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NORTH-EASTERN RHODESIA.*

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The land map of North-Eastern Rhodesia you have before you contains also part of North-Western Rhodesia; this part, bounded by the Kafue, Zambezi, Luangwa, Lukashaski and Mlembo rivers, and to the north by the Congo Free State, was but lately a portion of North-Eastern Rhodesia, and is thus included in to-night's paper.

During my first visit to North-Eastern Rhodesia in 1897 my journeys were confined to the northern part of the Tanganyika plateau between Lakes Mweru and Tanganyika and Fife, and further north in German territory to the low land which contains Lake Rukwa. Travelling further south over the country then was not everywhere possible—there was still some slave-trading being carried on, and the Awemba people had not been brought under control; but on my return two years later their power had been broken, and the whole of the country between Tanganyika had been tactfully, and with but little opposition, brought under the control of the British South Africa Company, and was quietly and peacefully administered from the many stations distributed over its area.

Travelling was easy, and the natives were friendly, so that any one could safely wander through country in which but a short time before it would have been unpleasant to travel without at least some show of force. It was to the same part of the country that I again went on my next visit; but from there I travelled further south on the plateau, and down the east and south of it on the low country, to which it falls as abruptly generally as it does to Rukwa and to Tanganyika.

* Read by O. L. Beringer at the Royal Geographical Society, November 12, 1906. Map, p. 484.

This high plateau comprises the greater portion of North-Eastern Rhodesia and is sharply divided from the rest of the country by a sudden drop, at the east and south-east, to the Luangwa and Zambezi valleys, and to the north by several prominent and almost continual drops—namely, that from the south end of Lake Mweru to and around the south of Lake Tanganyika, and, further to the north-east (in German territory), to Lake Rukwa and into its southern feeders rising at Fife, just over the Anglo-German boundary.

Between Lake Tanganyika and Rukwa, however, this high plateau from North-Eastern Rhodesia continues with but few depressions in a north-westerly direction until it reaches the large Malagarasi river (by far the greatest feeder of Lake Tanganyika), and forms in this long stretch the water divide between Tanganyika and the northern affluents of Rukwa and the said Malagarasi river. There is no similar continuation of this high North-Eastern Rhodesia plateau to the north between Lakes Mweru and Tanganyika, the country directly between these lakes being comparatively low and rising little over 3000 feet above sea-level, the approximate height of Mweru. Further north, however, the watershed between the Luapula river and Tanganyika is very high, and the west coast of this lake, like the country around the south and east of it, is very mountainous and rugged and consequently extremely picturesque, though, shut in as it is, ferociously hot—as Mr. Beringer, who surveyed the telegraph line up its eastern side, can vouch for.

These steep falls from the high land are very marked features of the country; they vary in depth from 2000 to 3000 feet, and occasionally near the edges are hills rising some hundreds of feet higher. They extend from near Tanganyika, on the north in German Territory, nearly all the way to Lake Nyasa, and are known over a great part of this stretch as Chingamba; on the east, but separated by the high land between Fife and Fort Hill from the northern portion, it forms the great drop to the Luangwa valley down to about 14° S., and is known all over this extent as Machinga. Continuing south-eastwards, but deeply cut into by the Lukashashi and Lusersfwa rivers and their affluents, and still generally called Machinga, it fades out in the high lands drained by the Kafue river.

On the northern boundary of this plateau the country varies from 5000 to 6000 feet in height above sea-level, but there are hills which rise much higher, such as Sunzu, for example, near Lake Tanganyika, 7393 feet (Close and Boileau). There is little over 5000 feet on the eastern boundary, and on the south the highest falls to about 4000 feet, though on the Zambezi-Luapula watershed, of which the Trumi mountains are a part, a height of nearly 5000 feet is maintained.

The sudden drop from the plateau on the north is shown by the heights of Tanganyika, 2680 feet (Close and Boileau), and of Rukwa, which I found to be at the same level as Tanganyika. On the east the

Luangwa river near Mirongo is 2500 feet, at Nawalia 1500 feet, above the sea, and both these places are within a few miles of the top of the Machinga.

On the north and east the watershed between the Congo and the rivers flowing north and east lies near the edge of the plateau, but on the south, from the Trumi mountains it turns across the high land in a north-westerly direction almost at right angles to the Machinga, and so divides this high country into a *northern and a southern part*, the former comprising nearly all the high ground of the present North-Eastern Rhodesia land, including a strip of country belonging to the Congo State

LUANGWA RIVER.

(between the Congo-Zambezi watershed and the Luapula river), and the latter most of that part of the country already described as having lately been included in North-Western Rhodesia.

Dividing the whole of this high land from the rest of North-Eastern Rhodesia is the extraordinarily deep valley of the Luangwa river, to which we shall again refer. To the east and south of this valley North-Eastern Rhodesia is bounded respectively by the Nyasa-Luangwa Zambezi watershed, and a line on that watershed on the 14th degree of latitude running to the 15th degree of latitude on the Luangwa river. Away from the Luangwa valley this part of North-Eastern Rhodesia rises generally to between 3000 and 4000 feet, but the rise is, except from that high country between Fort Hill and a little south of the Katumbi,

gradual. This high country to the north includes part of the Nyika plateau, which rises to a height of 8500 feet above sea-level, and Namitawa, 7239 feet, besides many other conspicuous peaks. Near the centre of the main northern plateau lies Lake Bangweulu, at a height of 3700 feet above the sea, and from the north, east, and south the land generally slopes gently towards it. The rivers running to it, after their first short fall from the ridge, flow slowly, sometimes through hilly and broken country, sometimes through gently undulating or level plains, and often through narrow swamps, many of which seem to have been at one time shallow lakes whose shrunken remains still show at places like Lake Young on the Mansya river and Lake Moir near Serenji. These small swamps get more frequent and larger as the rivers approach one another, and at last become one vast dead level morass, which, in its north-western part, changes from a dense papyrus marsh to a sheet of open water, and is then Lake Bangweulu. It was in this vast swamp that Livingstone got entangled at the worst part of the rainy season, with all the rivers in flood—a time of year when even now, in more settled circumstances, natives are with difficulty persuaded to travel far from their villages. In the beginning of February he was apparently not far from Chirui island, and certainly not more than two days by canoe from the firm ground which extends from the Luapula outlet round the south and west of Bangweulu, and the natives knew it, but kept him wandering, lost on the marshes till, nearly three months later, he ended his life and his wanderings near the edge of the swamp at old Chitambo's.

The principal river running to Bangweulu is the Chambezi, whose main source is in the high land 15 miles south of Tanganyika. It receives all the drainage from the north-eastern part of the plateau, and soon becomes a good-sized stream, with long reaches navigable by boat and canoe, and passes through much picturesque country and good farming land before it reaches the Bangweulu marshes and joins the Luapula.

The Luapula flows out from the south of Bangweulu, and, after running 50 miles due south through the swamps, takes a long bend round to the north again, and in a shallow valley, as a large and sometimes navigable river, reaches Lake Mweru, 350 miles, in which distance it falls only 700 feet, Mweru being 3000 feet above the sea. Water, therefore, which rose only 15 miles south of Tanganyika, after travelling 700 miles round the south of Bangweulu to the north of Mweru, is still only 90 miles from Tanganyika, and after having fallen nearly 3000 feet, is still 400 feet above it. Tanganyika, a sudden and very deep depression in very high country, sometimes with precipitous sides, differs much from the shallower lakes of Mweru and Bangweulu, with their stretches of swampy margin.

I was only once fortunate enough to visit Lake Bangweulu, and then

only saw its southern end. My object was to find the exit or exits of the Luapula river, on which the position of a portion of the Anglo-Congolese boundary depends. It was just after the end of the dry season when I arrived at Chongolo's, on the Luapula. It had been my intention to go in canoes from this point up the river to its exit from the lake, but Captain Bright, of the Buffs, then commandant of the North-Eastern Rhodesia constabulary, who two months before was journeying up the west side of Bangweulu, had, with the help of the native commissioner, collected a fleet of canoes and had succeeded, with much discomfort but no great difficulty, in paddling up this part of the river, and had found

CHIMANABUI RIVER.

the Luapula exit to be, as it was shown on the map, at Panta. Captain Bright kindly sent me his observations for latitudes and time, and his sketch of the river through the Bangweulu swamp, and I was thus at liberty to take a more westerly route on drier land from Chongolo's to the lake.

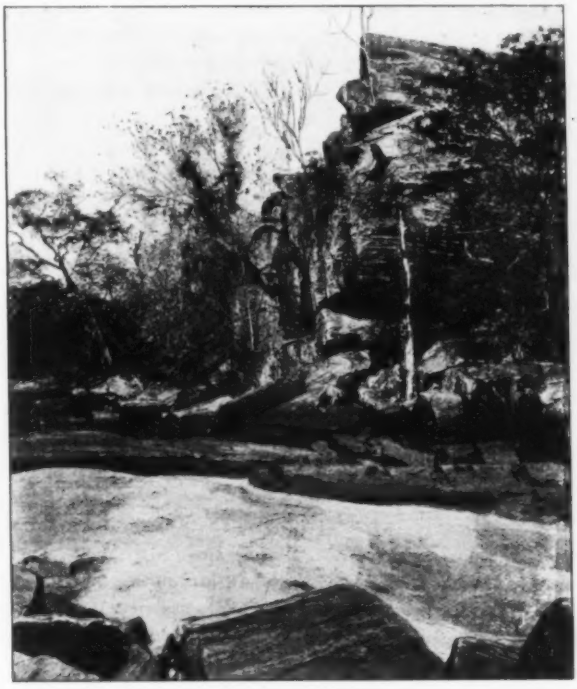
Approaching Chongolo's from the south-east and east is very gently undulating country, mostly brush-covered on the higher parts, but in the shallow hollows bare and often swampy; near the Luapula it becomes level open plain, dotted with clumps of trees and palms which are nearly always growing on or around an ant-heap. Narrow arms of

the swamp extend into the plain, and pools or little lakes of open water are frequent near the edge. Wildfowl of many sorts abound, and elephants may occasionally be seen wandering safely in their wise way over treacherous ground, which at first sight one would never think could bear them. At Chongolo's the Luapula, flowing due south, emerges from the swamp, and is there a deep stream 150 to 200 yards in width, with a strong current, between steep banks 16 feet in height. The water rises to and perhaps over these banks in the rainy season, but not much over them, for Chongolo's village is built close to the edge, on a small rise which is not more than 2 or 3 feet above the general level of the plain. On leaving the swamp the river turns at once to the west, flowing in low and often swampy ground, but between well-defined banks, and not until past Sakontwi is it kept well within these banks by firm and much higher ground. On the north side of the river, crossing at Chongolo's, bordering on or extending into the swamp, is the same sort of level plain, gradually changing to gentle undulations, the bottoms of which are still mostly swamp, and the higher parts sometimes narrow tongues of bush, which, as the ground rises still higher to the west, merge into the general thin forest of the country. This gradual rise from swamp to forest causes the boundary between dry and flooded lands to fluctuate very much, but the worst of floods would not extend beyond a line drawn from Sakontwi, through Kalasa's, and up the western side of the Musaba swamp, and even then the bulk of the bush-covered country between this swamp and Kampalombo and the whole of Kapata would be high above any water.

My routes from Chongolo's to the lake and back are shown on the map; that on the way up was by Kalasa's, Kawongo's on the Musaba, Kampalombo, and Kapata. Not knowing the country, nor anywhere being able to see far, and being guided in directions which varied only between the limits of north-west and south-east, Bangweulu began then to take on for me a complicated appearance; at the ferries at Kawongo's and Mlakwa's I suspected other connections between Bangweulu and the Luapula besides that at Panta, or that I had struck the lake 25 miles south of that point. I was not at Bangweulu yet, however, but at a large sheet of water, known as Kampalombo, to the south of it, which later I found to be only a backwater from the Luapula, whilst Musaba is a long narrow swamp which drains to it from the comparatively high land lying just to the south-west of the lake. Kapata is the name given to a narrow forest-covered tongue of land, rising to 50 feet in height, which stretches southwards from Bangweulu 20 miles into Kampalombo. At the north end of this tongue is Panta, a point 30 feet above water-level, from which to the west there is a clear view across to Mbawala island, and to the east, over the exit of the Luapula and the vast green swamp beyond to a distant horizon as level as that of the open water to the north.

The outflow from Bangweulu at this point is at its commencement about a mile wide, between well-defined walls of papyrus, but it soon narrows down to less than 300 yards, when there is a very slow current. It keeps a tortuous course on its way south through the swamps, and does not flow into the open water of Kampalombo, though it is joined up with it through the swamp by many canoe-tracks, which, at the time I was there, did not carry enough water (it was said) to float the canoes.

From the Luapula at Panta to Chirui island the swamp on the east



LUKUSYA RIVER.

is of dense papyrus, and there is no stream of water through it either to or from the lake. From Panta to the south-west corner of Bangweulu the bank rises steeply from the swamp fringe of the lake to from 30 feet to 40 feet above it, except at one spot where Kampalombo is only separated by a low sand-ridge, which is not, however, low enough to be crossed by water at any time of the year; at Panta, therefore, is the only exit from the lake. This low sand-ridge is now covered by scanty vegetation, and the northern point of Kampalombo is a narrow swamp

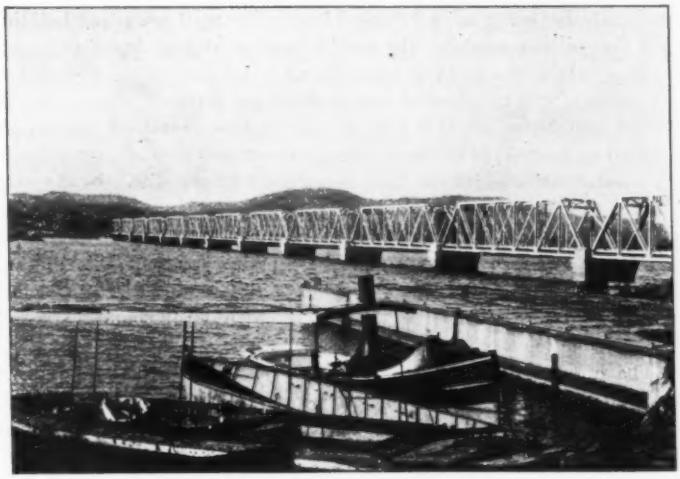
reaching up to it; but when the water-level of Bangweulu was higher, as it undoubtedly has been, Kampalombo was a southern extension of the lake, and Kapata but a low sandy island, as Mbawala now is, lying in the line of a current from the north-east, which then possibly scoured out the steep bank on the south from the thick horizontal sheet of laterite which makes it. The very picturesque little lake at Mano drains into Bangweulu, and is fed by two small streams which come from the higher forest-clad country mentioned as separating it from the head of the Musaba swamp.

The Chambezi does not flow into Bangweulu, but joins the Luapula in the swamp to the south, which accounts for the flood rise of 16 feet or more in the river at Chongolo's, whilst Bangweulu itself does not fluctuate much over 2 feet between its winter and summer levels. The flood-waters of the Chambezi, spread out as they are over a large area of swamp and filtered by its thick vegetation, are surely and not slowly converting the swamp into drier land, whilst the Luapula as surely, but much more slowly, is deepening its course and draining Bangweulu. It has cut its bed now 20 feet below the plain at Chongolo's, and 10 feet of this is through the laterite which formed under the swamp when the exit of the river from the lake was nearer to Sakontwi than to Panta, and the lake and the swamps to the east and north-east covered double or treble the area they do now.

Excepting in the swamps and on a few high hills, nearly the whole of the high lands of North-Eastern Rhodesia are covered with thin forest, which is evergreen even in the driest parts, and it is in the driest time—four or five weeks before rain—that this forest begins to put on new foliage; in fact, breaks out into its most gorgeous colours. It was early in September, before there is, as a rule, any sign of rain, that Thomson, after climbing the Machinga to this plateau, described this foliage as the rich colours of a "dawning spring, gorgeous yet delicate, surpassing anything to be seen in the autumn glories of our own woodlands, or in the flowery splendours of a Moorish summer. Ruby and crimson prevailed, and, massed together, glowed under the tropic sun like a field of living flame."

The forest is at this time said by the natives to be praying for rain, but it is fire, unfortunately, which it often gets, for during the last months of the dry season patches of forest are cleared for new gardens; small trees are cut down, and the upper branches of big ones lopped off, so that only the high stumps are left. The brushwood and leafy branches thus cut are all heaped on the patches which are to be cultivated (only one-fifth to one-tenth of the extent cut down), and there left to dry. Just before the rains these heaps are burned and the ashes and charcoal raked into the soil beneath, and in this as soon as the rains commence the seed is sown. At the time of the burning, though the trees have put on all their new foliage, the grass is still very dry, and

should the fire spread the whole of this foliage is scorched, and the trees are left nearly leafless on parched ground strewn with their charred or shrivelled leaves. It is some time before the trees begin to recover, and then all the foliage comes out on the trunk and main branches, none of it on new wood, and all new growth is destroyed at least for one year, perhaps for more. Fires lighted earlier, when the grass is not so dry and new foliage has not sprouted, would not do so much harm, possibly no harm; but natives will not burn it then, for should the fire spread to their newly cleared ground before the cut and heaped wood is dry, only the dried leaves and small twigs then burn, there is no ash and charcoal to rake into the ground, and no crops can be sown. Not



BRIDGE OVER THE KAFUE RIVER.

only the labour of clearing is lost, but the garden also is lost for the year, for it is too late to begin again. This form of cultivation is mostly employed for growing a small corn called malezi, which can be grown on poor soil, and which is grown much, for it is not only a staple food, but also makes the best of beer.

That the soil is not everywhere rich does not mean that there are no good lands for farming. The country is large, and the extent of suitable farming land makes up, in the aggregate, a very large area. It is well distributed throughout the whole of the highlands, and some areas would carry a large number of farms each with good arable and grazing land. The best areas, or at any rate the most convenient at first, are those in the high lands where there are many small streams, and in the lower land only close along the larger rivers; for where the streams are larger

and not so numerous, the great tracts of forest-covered country between are not suitable for European dwellings, and though they are used by the natives for gardens during the wet season, they are abandoned for want of drinking-water in the dry weather. It is surface water that fails; that there is water not far beneath the surface is shown by the sprouting of the forest long before any rains have fallen, and wherever water has been sunk for it has been found. A few farms have been started near Fife and Abercorn and on the Luapula, but as yet there is no market for agricultural produce; only cattle are being farmed, and these have done extremely well. Some agricultural produce (wheat, potatoes, etc.) has been grown by the various missionary societies whose estates are scattered through the country, and who have many of them done good pioneering work, bringing land under cultivation and building good houses, and teaching the natives such trades as carpentering and building. It is due to their teaching, also, that so many natives can be and are employed in offices as telegraphists and type-writers.

The population on this part of the plateau (north of the Congo-Zambezi watershed) is nowhere dense; it averages over all, according to the latest returns, which are fairly complete, 3·12 per mile. In the west, between the Luapula and Bangweulu it is densest, being 4·23 to the mile; in the north, including the Awemba country, it is 4·0; but it diminishes in the centre to only 2·5, falling in the south-east around Serenje and Mpika to less than 1·0 per mile. The country in these last districts is well watered and as fertile as the rest, the scarcity of population being probably due to old Awemba raids.

The high country in the Congo basin just described comprises two-fifths of the present extent of North-Eastern Rhodesia. That to the south, as already described as being now part of North-Western Rhodesia, is not in appearance very different from that on the north; it too, after the first fall from the ridge, slopes gently to the swampy plains which border the Kafue, or to the edge of the Machinga, which can be considered to end at the Bolengwe gorge, below where the railway crosses the Kafue at a height of over 3200 feet above the sea. The rivers which drain this high land to the Luangwa, like those to Rukwa, fall from it in cascades and waterfalls, or have cut deep gorges back into the Machinga, down which they rush as mountain torrents, to be absorbed or become half-stagnant streams in the hot country below.

One noticeable difference, however, in this southern high land is the prevalence throughout it of crystalline limestones or marble, of which I have not seen a sign north of the ridge.* This has not much effect on the scenery, except perhaps that there are more often open dry plains, and the country generally is not quite so thickly wooded. It is in this limestone near the lesser Kafue river that the peculiar isolated deep

* These limestones occur again, however, on the west side of Tanganyika, in the Congo State.

pools exist, which have been sometimes described, I believe, as the mouths of extinct volcanoes, and sometimes as "old workings." Some are simply deep pools of perfectly clear water, with steep or perpendicular limestone edges surrounded by dense vegetation. They do not lie on any line of surface drainage, and are probably the result of falling in of caves in the limestone below. The most remarkable one I saw was one called Chirengwa, just north of Chiwala's, on the lesser Kafue; it is a sudden, nearly square depression 250 yards across, near the crest of a gentle undulation in bush-covered country. The forest grows up to the edge of the depression and extends down the sides, which slope at an angle varying from 31° to 48° and fall 150 feet to the water, which in this case is not very clear nor deep, and is on a muddy bottom. The rock outcropping on the sides near the water is a light-coloured sandy shale or schist steeply dipping to the north-east. The schist is the same as that often accompanying the crystalline limestones, which here lie beneath it, and outcrop in the Kafue with a dip of 60° in the same direction. There is nothing to indicate how the depression was caused, and the sides are weathered to *débris*, which covers all but a few small outcrops of the rock. There is no sign of igneous rock anywhere near, nor are there any heaps of excavated material, and this, like the other pools, is probably also the result of a fallen-in cave. It is reported to be the home of that mythical animal the chibekwe, or water-rhinoceros, which lives in such secluded places and in deep lakes, has apparently the peculiarity of leaving no spoor, and whose daily food is a big hippopotamus. Mr. Neave told me of another of these pools which he had visited; it had steep limestone sides, the water was very clear and cold, and rose to near the ground-level; it was very deep, and though he sounded 300 feet, he did not find the bottom, nor did he, I believe, meet with the chibekwe.

It is amongst these limestones that the rich mines of copper, zinc, and lead are found, many of which have been worked some time in the past, some only on the surface, but others deeper, galleries having been found 100 feet deep (in the Bwana M'Kubwa); but, as in the old workings elsewhere in Rhodesia, nothing has yet been found which determines the time at which these workings were carried on.

The railway from the Cape is now at Broken hill, the first of these mines of lead and zinc. Its continuation will take it past the Bwana M'Kubwa copper-mine and other large mining properties to the Congo border, where it will not be far from the Katanga country, probably one of the richest mineralized areas known. The effect of the railway on this part of the country should be very great, for it passes through much level alluvial plain, well suited for agriculture, and the mines are even now a very ready market. There is room for many farms along the railway, and not far from the mines; perhaps even for small farms, which are not generally considered possible in South Africa. At

Kalomo, in North-West Rhodesia, I saw one farm where the owner, experienced in the United States as well as in South Africa, had, with the help of but little agricultural machinery, put 800 acres under corn this year, and though it is too early yet to boast, he was very confident of success.

This part of the high land (between the Kafue river and the Congo-Zambezi watershed) is thinly populated, the density being only 1·6 per mile, exactly why is difficult to see. There are, it is true, large scantily watered areas in it, and possibly it gets on the whole a smaller rainfall, but there are also large areas along rivers with abundant water all the year round, where very few people live. Where the population has settled they get good crops, and have been able to sell large quantities of food to the mines, but of cattle there are almost none.

Over the whole of the plateau game of all sorts is fairly abundant, and is very much on the increase; the natives have now no guns, and of the Europeans who live most amongst the game few shoot more than they need for food, or for a good head or trophy. Wise game laws, making the purchase of licences necessary to all those desiring to shoot, both officials and others, and limiting the numbers to be shot, also tend to this desirable result. The desire to kill or make a big bag does not last very long with those who often must kill to keep their carriers in food, or at least in good temper by a change of diet from the monotony of only corn; and to do this is not unimportant when a white man has to travel for weeks with the same carriers, whose principal inducement, and perhaps only pleasure, in keeping with him is often the change to a meat diet. The hippopotamus is found in most of the larger streams, and as his carcase is enormous and the meat good, it is not unseldom sought for this purpose, and though a dead hippopotamus may mean at least a day's delay whilst the meat is being cut up and ied, the killing does not necessitate much deviation from the route, and almost never the following of a wounded beast. Elephants are plentiful in the west and centre of the plateau, but are also found in small herds almost everywhere. Shooting them is not such an easy matter, for, except with extraordinary luck, the time and labour needed to get up to them are too much for a man on an ordinary journey, from which he is not prepared to deviate far; and sometimes, if he would not leave a wounded animal, it means toiling for days far from his route and in any direction but that he wishes to travel. All of the Europeans in the country are employed on some work or other, and can seldom give up the time on their journeys for such amusement, however great the temptation of the chase of a big bull elephant, with a pair of good tusks as a trophy; and unless full time can be given, a chase begun mostly ends in the late return of the disappointed hunter, weary and tired to stumbling, with every inequality of the ground a stumbling-block, and every tuft of grass a trap, still far from the carriers and the camp

VIEW FROM MUCHINGA MOUNTAINS, NEAR MIRONGO.

he left earlier in the day, of whose whereabouts now he has no sure idea.

The rhinoceros is much less common, and, though it is found in many parts of the plateau, does not wander so far as the elephant, and is not often seen except in the patches of country it is well known to haunt. Buffaloes, also, are increasing, though there are no large herds; to them and to the rhinoceros the natives often attribute the spread of the tsetse fly. Eland, roan, and hartebeeste are met with everywhere, but kudu and sable are more confined to special areas; the sasabe and lechwe are found in the larger swampy places, and the sititunga in many swamps, but the sportsman must be up very early to see one. The puku is the commonest of the smallest antelopes, but waterbuck, bushbuck, reedbuck, oribi, and impala are all met with, in places plentifully, and the duiker is everywhere.

The low lands of North-Eastern Rhodesia are included in the Luangwa valley; the contrast between these and the high country is very great, and the change from one to the other is very sudden, there being but little intermediate ground, and, as if to emphasize the contrast, this valley, which is deep from its commencement, starts from near the Nyika plateau, 8500 feet above the sea, the highest land in the country, amidst patches of heavy virgin forest, plentifully watered and occasionally snowed upon. From this small plateau springs the high spur which separates the Luangwa valley from Nyasa, and, continuing south as still a high range, dies down only between the Shiré and Zambezi rivers. This spur is on its Nyasa slope fairly well watered, but on the Luangwa side, from the Nyika plateau to Tete, there is no river except the Luumbu (rising in the plateau itself), which in the winter (dry) season does not dry up before it reaches the Luangwa or the Zambezi, and most of them are dry from their sources. Rain fails constantly on this western slope, especially towards the Zambezi, and food is every year scarce, often to the extent of famine. This ridge has a great effect on the Luangwa valley, which, shut in by high hills on both sides, is very hot, and more typically tropical than the high lands, but tropical in its heat more than in a constant luxuriance of vegetation; for though in the rainy season, with full and overflowing rivers and a steamy atmosphere, the vegetation would vie in luxuriance with that of any other part of the world, yet the long dry season completely alters its appearance. The south-east winds that blow across it arrive desiccated by the ridge they have crossed on their way, and, getting warm in the valley, are thirsty to take away what moisture they can find to the hills again on the far side. The streams from the steep hillsides soon run off their supply of water, those on the left bank, as already said, all dry up, and those from the Machinga become most of them at best but a chain of stagnant pools soon after they reach the plain. In the great heat the trees drop all their leaves, and over large areas grass fires leave the ground bare as well as shade-

less, and the Luangwa itself then dwindles to a comparatively small stream meandering in a wide sandy bed, which in places, where the hills come close to the river, is used as the easiest road through the country.

Two interesting features of part of this country Mr. Beringer mentions. The first is the peculiar watershed formation of Lake Nyasa and the Luangwa river between lats. 11° and 12° 15′. For a distance of nearly 90 miles the Kukuru river runs generally not more than from a quarter to 3 miles away from this watershed. The country between, except for a few isolated hills, is very flat. On the other hand, the country to the east, in British Central Africa, is very mountainous

VIEW FROM ILONDA HILL, TANGANYIKA.

and higher than the watershed; consequently, whilst the Kukuru river is plentifully supplied with water into its right bank, the left bank and the entire country between it and the Luangwa river, within the above latitudes, is for the greater part of the year waterless. Directly to the west of this watershed the country is very broken, and falls more or less steeply into the Luangwa valley some 2000 feet below. The other interesting feature is, that in many places within a few miles north and south of 11° 30′ lat. the land is crumbling and falling away into the Luangwa valley to such an extent that in a comparatively short time it will have reached and drained a large stretch of the upper waters of the Kukuru river into the Luangwa. A very shallow and short cutting would anticipate this now.

But though the Luangwa valley is unpleasantly hot to one accustomed to the higher lands, it has its riches and attractions. It is the

home of the biggest of big game—the elephant, rhinoceros, hippopotamus, buffalo, and lion are to be found in most parts of it; the few giraffes left in the country are there (they have a large reserve set aside for them). Eland, wildebeeste, roan, sable, kudu, and many of the smaller antelopes are each of them fairly plentiful in some part of the valley, and the sportsman or naturalist who has no need to push on a day's journey each day can always find shaded and pleasant, if somewhat warm, camping-grounds near some pool on higher land away from the beaten track.

But not for sport only is the country good; its rich cotton soil is probably its best recommendation. The natives of the valley have always grown cotton, and still grow it in small quantities, and the British South Africa Company have for some little time had experimental plantations on which foreign as well as native cotton seeds have been tried with great success. The deep black soil of much of the valley is said by Mr. de Josselin de Jong, the Superintendent of Agriculture, to be "an ideal soil for cotton, and the cotton bushes of the natives, who have a very simple mode of cultivation, bear good crops for many years; they never cut down their trees, and seldom root them up to plant new ones. A little hoeing round the trees," he says, "is the only sign of cultivation, and the growing power of the bushes and the continuous good crops speak much for the soil and the suitability of the Luangwa valley." Samples of native cotton sent home were valued at from 7*d.* to 8*d.* per pound, some of it from almost uncultivated trees seven years old.

The Luangwa valley is over 400 miles long, and for at least 250 miles of this it is bordered by alluvial plain, much of it of red unsuitable ground, but still much of it of black "ideal soil," and it is to be hoped that it may yet be utilized for the purpose for which it seems so fitted. In this valley, as indeed over much of the country, the Sanseveiria fibre grows plentifully, but scattered too much over large areas to make its systematic collection profitable. The fibre is valuable and easily cultivated, and with cotton and the bye-products of cotton (oil and oil-cake), together they may make this valley worth much in time, to the benefit of the people and much to the regret of the sportsman; for the tse-tse fly is abundant and cannot be exterminated, so that the game must be killed off sometime before the domestic animals necessary for agriculture can be moved in from the places still free from "fly."

It is in this valley, also, that there are some extensive forests of useful timber—the mopani tree, which grows in low land in open forest with but little undergrowth. The forests near the Luangwa are often almost entirely composed of this tree, which grows with a straight stem, and throws out no spreading branches; the wood is dark and hard, and good for all building purposes, for white ants will not touch it, and will be very valuable for mining timber.

Within the valley, but distinct from it, is one small piece of country, around Fort Jameson and eastwards, which, ranging in height from 3000 to 4000 feet, resembles almost the country of the plateau. It is near the Luangwa-Nyasa watershed, where this is widened out by the spur which divides the Luangwa from the Zambezi. The watershed here is on the highest land, unlike that to the north, where still higher hills lie between it and Lake Nyasa. It is not, therefore, here robbed of so much of its rain, with the result that it is both fertile and thickly populated. The difference, however, between the eastern and western slopes is still very great, and, whereas on the east, good-sized rivers run down to the lake, on the west the streams do not in dry weather carry water many miles from their sources. It receives an annual rainfall of 39 inches, of which over 37 fall in the five months from November to March, and the south-east winds blow for five out of the

SOUTH END OF LAKE TANGANYIKA.

other seven months almost absolutely dry. It is in this part of the country that a portion of the Zulu armies (now calling themselves the Angoni) settled after their migration from the south, bringing with them southern cattle, and soon making themselves masters of the country. It is a good cattle country, and still has more cattle and is more densely populated than any other part of North-Eastern Rhodesia. It carries ten people to the mile over an area of 5000 square miles, while the rest of the Luangwa valley averages only 2·2, and in none of its divisions rises to 3·0.

In the whole country, including the plateau and that between the Luangwa and the Kafue rivers, the population hardly reaches or only just passes 400,000 souls, an average of 2·6 per mile.

Both of my visits to the country were made principally with the idea of seeing and shooting in what was much of it new country; but wandering and shooting, even in new and interesting country, are in themselves but poor amusement for more than a limited time, and I spent much of mine on all my journeys in astronomically mapping my routes, and added to the pleasure of simple tramp and sport the interest of seeing the country's shape and structure gradually develop on paper. But the country is big, the means of locomotion slow, and the interests of shooting and of mapping were often greatly opposed, so that the progress on the map was lamentably small. In this manner, however, I had mapped about 3000 miles of route—some of the routes two or more times, and many crossing one another or touching at not very distant intervals—when I was fortunate enough to join the British South Africa Company, to start and take charge of their Survey Department in North-Eastern Rhodesia. All the work I had done became then of immediate use, and, with that which soon followed from able and willing assistants, helped to make the groundwork of the present map, of which now my work is very much the smaller part.

The Survey Department could not give much of its time to mapping only, for its first work was the survey of farms and townships and small areas, which together add but little to the map. By utilizing, however, all surveyed routes, and continuing to survey the route of every journey made by a surveyor, a skeleton map is growing, on which all surveys of isolated farms, and plane-table surveys of larger areas, can be placed in their respective positions, and for further filling in, till better survey is done, the routes and sketch-maps made by magistrates and native commissioners between known points on the skeleton can be utilized. Absolute longitude is taken from the beacons at Fife and Mambwe, on the Anglo-German border, and at Fort Jameson, which I was enabled to fix by signals from Cape Town Observatory. At present there are over 5000 miles of astronomically surveyed routes, all connected with one another and with these fixed points, and on them the principal stations have been fixed fairly closely in latitude and in time, and other points

have been determined in the same manner every 12 to 18 miles, the road between being filled in by compass bearings and sketches. An accurate trigonometrical survey of the country cannot be hoped for for very many years, but on such a network of surveyed routes the general features of the country can be shown with not much distortion, and as more and more survey gradually takes the place of sketches, it should form a constantly improving map, which will be of general use until one based on more accurate triangulation can be made.

SOUTH END OF LAKE BANGWEULU.

The map is being plotted on a scale of 1 : 250,000, but as on this only the routes and actual surveys are plotted, there are too many blank spaces and even blank sheets for the map to be of any public interest; a smaller map therefore, on a scale of 1 : 1,000,000, has been prepared. It is based on the same information as the large map, but Mr. Beringer, who made some of the surveyed routes and most of the plane-table survey in the country, has, with infinite labour, incorporated with this all the information given on the many scores of sketches and route and compass surveys made by the various district officials, often only isolated small sketches

which the surveyed routes have enabled him to locate and orient, and descriptions and aneroid readings which have guided him in showing on his map the general contours of the country.

Accompanying the map is a smaller one, showing in black lines the network of routes on which it is founded, and the areas which have been surveyed. The heavier lines are all astronomically surveyed routes; the thinner lines are routes on which only latitudes were taken. The meshes in the net are very unequal in size, and some as yet are very large, but the large number of compass sketches and surveys of many of the district officials have enabled these gaps to be filled in with, it is believed, such a near approach to truth as to make the map of real use until better survey can be substituted. On the southern border the plane-table survey is partly taken from work done by the Anglo-Portuguese Boundary Commission; the eastern boundary was all plane-tabled by Mr. Beringer, starting from measured bases in and near Fort Jameson, and checked on the way by observations for latitude and azimuth, and again on the beacons of the Anglo-German boundary, which were thus connected with those on the southern border.

On the north, the map of the Boundary Commission is used, augmented by work done by Mr. Beringer, both in the trigonometrical survey of farms and by plane-table. A little plane-tabling has also been done on the new boundary between North-Eastern and North-Western Rhodesia, and over a small area round Fort Jameson. This plane-table work has always been done with astronomical checks, but always, also, on the principle that it was more useful at present to spend time in getting a fairly true survey of a large tract of country than to use it in accurate survey of the details of much more limited areas. From the above description of what the map is based on, it will be understood that it does not claim to be all surveyed, and from the accompanying key map the relative accuracy of the different parts of it can be estimated, and may be a guide to others, as it is to us, what parts of it we may and what may not alter in adjusting new routes or sketches to it.

Unfortunately, none of the work of the Geodetic Survey has come in time to be incorporated in the map. This survey was started in the beginning of 1903, the Chartered Company having decided to continue it for three years, under the direction of Sir David Gill, believing that in time it would reach Tanganyika. Though Dr. Rubin, who was engaged by Sir David Gill to take charge of the work, arrived in the country early in 1903, work on the survey did not begin until the next year, for unfortunately (for the Geodetic Survey) he was employed for the greater part of the first year in delimiting the Anglo-Portuguese frontier south of the Zambezi, the opportunity of his presence there being taken to mark off the true meridian which at this point forms the boundary. A second misfortune was that the years 1903–4 were years of drought and

great scarcity of food, in places of real famine, in that part of the Zambezi valley, and there were consequently many delays caused by the difficulties in organizing the transport and food necessary, and even in providing water where stations had to be occupied for weeks, miles from any stream or pool. The very dense haze which settles over the country often interrupted work, and it was not till October, 1904, that Dr. Rubin and his assistants were well north of the Zambezi and employed on the measurement of a base-line in the Luangwa valley. Up to May, 1905, the survey had covered two degrees of latitude out of the eight necessary to reach Tanganyika. The three years allowed are now over, and the Geodetic Survey will be again interrupted for some time. About half of the field work has been done, and it is to be hoped that, on account of its great interest, means may be found to continue it soon.

GEOLOGY.

In a country without a map it is not often easy to recognize at once the geological structure in any but its most obvious features; when the first routes made through it are plotted on an otherwise blank sheet of map they are but lines widely separated, and as they are often for days over alluvial plain where notes are of necessity few, or in bush where vision is very limited, and information gathered seems so little on the widely separated lines and so often without any apparent connection—all the notes of months of travelling when placed on these beginnings of a map seem hopelessly useless. But as the number of journeys goes on increasing, the old notes begin to be more intelligible, and new ones convey a fuller meaning, or at least are open to a more immediate interpretation, and some form begins to show. The gaps between my routes are still very large; some too large for even a guess at their structure, others so surrounded by notes that it is not unsafe to come to conclusions about what rocks they contain. It is from this state of many routes with many large gaps and omissions that the following description of the geology of the country is given. In giving it, I will commence with the country of the Zambezi valley just outside of Rhodesia, on the south-east, passing on to the north-westward across the Luangwa and along the Machinga hills on the west of this river, then westward to Tanganyika and Mweru, turning thence south again through Bangweulu to the river Kafue, and I will leave to the last the description of the Luangwa valley.

Commencing, then, with the country between the Zambezi and Luangwa rivers and the Zambezi-Nyasa watershed as far north as 13° lat. This part of the country is nearly all granite, and many of the hills are typical granite bosses, some of them quite inaccessible and standing out 2000 feet above the surrounding country. Over the granite are scattered a few small areas of quartz- and mica-schists, which are but the comparatively small remnants of the Archæan rocks into which the granite was intrusive. These schists stand in almost vertical strata, sometimes amongst the hollows between the bare granite mountains; and often, as at Fort Jameson, they form only the tops of the hills in small and isolated patches. My routes over this country were from the Luangwa at lat. 12° 30′, through Fort Jameson to the Zambezi at Tete, and from the Anglo-Portuguese boundary along lat. 14° to the Luangwa, and again from Fort Jameson to the Luangwa

on a route 30 miles to the north of this; and these routes are almost entirely on only granite, which, however, is often distinctly foliated over large areas, graduating from a granitoid to a foliated structure, and passing at times into a coarse-grained gneiss, interbedded occasionally with the schists where these are found on the granite.

The Zambezi at Tete flows over a soft horizontal sandstone, which will be noticed later, but a few miles up-stream it comes through hills of interstratified and nearly vertical schists and gneisses, with which is a single stratum of coarsely crystalline limestone stained occasionally with malachite; their strike is across the river to the north-east, but it turns in 10 miles to the north. A little further up-stream the Kabrabasa rapids come over granite, which extends up the river many miles; I have not seen how far. From here in a north-westerly direction for 170 miles is granite, and granite only, to Sasare, where are again some nearly vertical gneisses and quartz- and mica-schists highly impregnated with copper, all with a general strike about north-north-east. Again amongst them is a stratum of coarsely crystalline limestone, which can be traced at intervals for 50 miles, and 60 miles further to the north-east a similar stratum (or perhaps the same, but here it is dolomitic) occurs interbedded with gneiss with the same steep dip and strike to the north-east, but with no quartz-schists. This strip of schists at Sasare is not on the edge of the granite, for across these, 2 or 3 miles to the north-west, is again granite, which extends beyond the Luangwa to the Machinga. It would seem that these Archæan schists were lying in folds with a north-east and south-west direction when the granite was forced into them, since when, at least over this area, they have nearly disappeared.

Crossing now to the western side of the Luangwa river, granite and much more abundant schists make up the whole of the Machinga range from the Lusenfwa river north-eastwards to beyond Mirongo. The schists, amongst which quartzites and quartz-schists are much the greater part, dip always at very steep angles, which vary even in the same stratum from side to side, and are always nearly vertical; they have a general strike north-eastwards, with occasional sudden variations to a direction at right angles to this. On the plateau above they show with the same strike and sudden contortions over a strip of country parallel with the range, and varying in width from 20 to 40 miles measured back from the edge of the Machinga. Their outcrop, striking north-east and alternating with granite, is seen along the road as far west as Mkushi, and again halfway between Serenje and Sakontwi, with a strike to the north, and as, crossing them there, the dip varies in a very few miles from east to west, it probably shows a steep anticlinal fold. On this high ground the rocks are much covered by alluvial soil and disintegrated rock, but they show in the hills and in many streams occasionally as walls of rock running across the centre, and often as lines of vertical wind-worn slabs which have almost an artificial appearance of regularity.

They vary from soft micaceous sandstone to brittle laminated quartzite which seems to weather to itacolumnite, and some are sugary quartzites which when weathered are on the surface a loose white sandstone, but when broken are at the core an almost translucent bluish glass-like quartz or an aggregate of transparent crystalline quartz grains from very minute to nearly the size of peas; the more weathered rocks often containing large cubes of limonite, pseudomorphs after pyrites, which still show clearly on their faces the striations of the original crystals. Amongst the softer rocks are mica-schists and phyllites, and some soft argillaceous rocks studded with what once were crystals, but all so decayed and altered now that it is impossible to name them off-hand. Granite is very much mixed up with the schists, and in the steep rise of the Machinga sometimes is exposed

only at the foot of the range, and as often forms the whole rise from bottom to top. On the high land back from the range it constantly appears through the schists, either as bold hills or as low flat domes rising only a few feet above the grass, and a little north of Mirongo it entirely takes the place of the schists, and, with some few schistose rocks of igneous origin near Fife, is the only rock from there westward along the Anglo-German boundary until within a few miles of Abercorn.

At Abercorn and westward, nearly if not quite to Mweru, are the Tanganyika sandstones, which face the south end of Tanganyika in cliffs and steep slopes, altogether amounting to over 3000 feet in thickness. They are generally a coarse red or grey sandy rock, with very few thin strata of shale, and are traversed in places by dark igneous dykes. Near the southernmost part of the lake the lowest exposed strata are very micaceous and laminar, and jointed into small roughly square blocks which weather and decay easily, and there and at Sumbu further west there are some signs of igneous rock (quartz felsites); and from a point a little northwards from Sumbu, on the Anglo-Congolese border, specimens of a red granite have been sent to me. Coming back now to a point about 6 miles eastwards from Abercorn, and over 3000 feet above the lake, there is a small escarpment facing south-east, down which the road falls some 200 feet, and the swamp at the foot of this is lying on crushed quartz-porphyry, which shows for the next 2 or 3 miles; then further on near the Kawimbi Mission is a high sandstone hill, on the far side of which the granites begin, and, as already said, extend all the way to beyond Fife.

From this junction with the granite the sandstones continue in a line about south-south-east to where the Lufubu joins the Chambezi river, and granite shows occasionally close up to them on the east. They end at the Chambezi river, across which are the schists of the Machinga. Following down the Chambezi river to its junction with the Mansya, and from there north-west to Mweru, the route is over the same sandstones. How far they extend south and west of this last line I do not know, for I have not been in that part of the country. Within this area (Tanganyika, Chambezi, and Mweru) they lie in easy undulations of about 12°, deeply cut into by numerous rivers and streams, and by them exposed in cliffs often hundreds of feet high, and, at least near their eastern and southern limits, the granite they lie on shows in the beds of some of these streams 2000 feet above the level of their lowest strata at Tanganyika.

Southwards from this sandstone area, and west of the Machinga schists, is the Bangweulu country covered with alluvium and swamp, and from the very little I have seen of it I can only guess at its more recent geological history. The Luapula at Sakontwi flows over a soft micaceous and rather muddy horizontal sandstone, which may be connected with the Tanganyika sandstones, but it is very unlike them, and without some knowledge of the country to the west it would be impossible to say. This rock may be connected with some soft horizontal sandstones in the Lukulu and Mansya rivers, near where they flow into the Chambezi, in which case they might well be recent lake deposits. I found, however, no remains in them of the lake life, and there is much that should leave its traces—oysters, for example, which now exist in the Chambezi and grow to a very large size.*

That Bangweulu has covered a much larger area eastward and up the Lukulu, Chambezi, and Mansya rivers goes almost without saying (the contour-map shows how little difference in height would be needed for this), for the rivers that pour

* These oysters are called ngiri by the natives, and are eaten by them.

in on its north and east sides have been piling mud on its shallow bed for centuries, and extending their deltas into it. That it has been higher than now there is evidence on its southern shore in the mud deposits and sheets of laterite, below which now the Luapula has cut its bed.

Not only here, but all over the country, this rock (laterite) is met with lying on or near the surface in a horizontal or nearly horizontal stratum; it varies much in hardness and structure, but its general appearance as a level sheet of rock with a dark brown and very rough surface is always the same. It consists generally of sand and even mould cemented together by iron oxide, and contains numerous cavities and channels lined more or less thickly with limonite. In places it takes on a pisolitic structure, the oxide forming round grains of sand or organic matter as a nucleus, and it is this form which weathers to the small round gravel so common on many native paths. Sometimes the lining of the cavities and channels is so thick, and they and the rock generally contain so much earthy oxide that large fragments have a specific gravity of 3·5. When broken up and picked over, this is the ore used by many of the native smelters of iron.

The rock is found everywhere in flat country, and even in any small area of flat or hollow ground. It shows round the sides and forms the bottom often of the damp open glades in the bush, where the soil that covers it is too thin for trees, and sometimes even for grass, in which case the rock soon becomes exposed in bare level patches; it forms the level plains bordering many of the streams and rivers, which now have cut through it to the clay or rock below, and have exposed a stratum sometimes over 10 feet thick, throughout which are embedded angular fragments, and, where the hills fall steeply to the edge of the plain, even large boulders of the country rock. From its constant mode of occurrence, it is easily seen that it has formed under swamps, or at least under very wet ground, and is still forming in almost every swamp in the country. On examining the mud and clay in the swamps, or where the natives have sunk in damp ground to get the softer ore for smelting, it is soon seen how like this mud, where it has hardened, often is to the softer laterites poor in iron; and where roots have rotted out and their tunnels are left, they often already show the harder lining of iron-stained material. Sometimes the dead root or small tuber is there, but more often the cavity is filled with mud or sand.

Along the same stream can often be seen, in one place a swamp with soft laterite under it, and the harder rock showing in the drier grass and bush which border it; in another place, where the obstacle which once kept back the water has been gradually worn away, the swamp above it has dried and become a slightly hollow grass plain, sometimes invaded by bush, but more often, denuded of its soil, it forms one of the many examples of a bare sheet of hardened laterite sloping gently to the edge of the stream, which has now cut its bed down deep below it. It is one of these thick sheets covered with soil that shows on the bank of the Luapula at Chongolo's, and in the steep southern bank of Bangweulu, in dry land 20 feet above the present water-level. Knowing its common mode of occurrence, it is impossible to see it there and in the Luapula and Luombwa rivers without coming to the conclusion that it formed under what was the Bangweulu swamp when these rivers were flowing at a much higher level.

Leaving Bangweulu and continuing further south to the country between the Congo-Zambezi watershed and the Kafue river and still keeping to the west of the Machinga schists, an entirely different set of rocks is met with, principally white and grey marble and mica- and quartz-schists. They are separated from the Machinga schists by a strip, 50 miles wide, of granite, which is the only rock showing, and that most abundantly, on the road between Mwushi and Mwomboshi.

West of Mwomboshi to beyond Sitanda, northwards to Chiwala's, and southwards to 40 or 50 miles beyond the Kafue river, these crystalline limestones and schists are lying in steep folds with a general east-and-west strike. Granite shows through them in some low hills between Mwomboshi and Kafue, and again near Sitanda; but the actual contact is not visible, for the country is not very hilly, and is covered by much soil, so that one may travel for 40 or 50 miles at a time and not see a sign of a rock, unless he has the time to deviate as he will from the route. The marbles vary in texture from fine to very coarsely crystalline, and in colour from white to very dark grey; they are in places very richly mineralized with copper, lead, zinc, and iron, the Broken Hill mine consisting of two small hills, one almost entirely of zinc, and the other of lead ore; and near the Kafue river is a fine hill of nothing but black, nearly pure hematite rock, finely crystalline throughout, and often very micaceous. Other mines are of copper, occurring mostly as huge pockets of sulphide, but the Bwana Mkubwa mine is said to be a true lode. There are many quartz reef outcrops, of which one found lately is believed to be very rich in gold, though this has yet to be proved. Some gold there is, but, except perhaps in this new reef, it has not been found in payable quantities.

Thus far the description has embraced first the granite country between the Zambezi and Luangwa rivers from Tete through Fort Jameson to lat. 13°; then, crossing the Luangwa on lat. 15°, it goes from the Lusenfwa river north-eastwards along the Machinga schists as a wide strip up to lat. 10°, where it comes to the granites again on the north, and passes eastward from these to the Tanganyika sandstones; then, turning southwards, it comes through the Bangweulu country and over the Congo-Zambezi watershed to the high land between this and the Kafue river. There remain to be described the Luangwa valley and the ridge between it and Lake Nyasa.

The spur between the Luangwa and Nyasa, north of Fort Jameson, is, like the country to the south of that place, mostly granite, with some Archæan schists up to as far north as Mount Waller, and after this, near the lake, are granite and schists again. Between Mount Waller and Fort Hill over the Nyika plateau is probably one of the most interesting parts geologically in North-Eastern Rhodesia, for there are to be seen the old schists and granite, the Mount Waller sandstones, Drummond's beds, which Mr. Moore says lie unconformably on them, and a series of other rocks, remnants of which show in the Luangwa valley and on the Lusenfwa and Lukashashi rivers, and again near the Zambezi as far down as Tete. I have made but one too short trip into this country, from Mirongo across the Luangwa to Katumbi's on the Luumbu river, and so only touched the southern edge of it. Between the Luangwa and Luumbu rivers near Katumbi's is a ridge of hills 1500 feet in height at this place, but rising higher further north. At their base in the Luumbu river are grey, compact, and somewhat sandy limestones, which on fracture show a sheen of reflected light from minute crystallization. Above these limestones, and at first sight almost indistinguishable from them, is a very fine ripple-marked grey sandstone, almost a shale, which is followed by a coarse, gritty arkose, and this by pinkish sandstones containing occasional very hard, compact, calcareous patches, which weather out of the rock and break with an almost conchoidal fracture; on the top are fine pink ripple-marked sandstones, which, like the limestone at the base, have a dip of 10° to the north-west.

Across the Luumbu river, that is eastward, and in places showing in its bed, are granite gneiss and schists, which extend to the Nyasa watershed, and separate these sandstones at this point (I have not seen further north) from those at Mount Waller. I do not know the Mount Waller rocks, but these Luumbu strata do not correspond with the description of them, and they are altogether unlike the

Tanganyika sandstones, which, as far as I have been able to see or hear, contain no lime whatever. From the foot of these sandstone hills westward on the lowland towards the Luangwa are thin strata of light grey limestone and fine grey shale-like sandstones, and above them a soft, rather coarse sandstone containing angular fragments of felspar, the ground over them being covered with water-worn pebbles of quartzite. Near the Luangwa is the alluvial deposit in which the river flows, and across this the first rock met with is granite, on which are the Machinga schists; lying against these, in a deep hollow 200 to 300 feet above the river, is a bed of hard conglomerate, with quartzite pebbles, which, though I did not see the limestone there nor the conglomerate at Luumbu, lies, as I saw later, in patches above the limestone. These thin strata of lime and sandstone in the low land east of the Luangwa have the same dip and strike as those in the Luumbu; but there is probably much faulting* between, and they are the same as the rather thicker beds at the base of the hills there. Except in their thickness, they are indistinguishable from them, and the coarse sandstone, with felspar fragments, represents the arkose of the Luumbu, so that all the other strata which lay above them have here disappeared.

Travelling now down the Luangwa valley, it will be remembered that the hills (the Machinga) on the right are granite and schists; on the left, granite and gneiss and schists, which are possibly older than those of the Machinga. The low land between is principally deep alluvial soil, but occasionally spurs run out into it as far as the river, and the river at times meanders near in to the hills. At the base of these low foothills, in the streams which have cut through them to the main river, are constantly to be seen the thin strata of grey limestone, overlain by coarse gritty sandstone, which again is occasionally arkose; and the ground above them is almost always strewn with well-rounded pebbles of quartzite. A little higher up these hills, in the more protected gulleys, are patches of horizontal strata of sandstones, generally red, which reach in places 500 feet above the river, and lie on the schists or directly on the granite; the base of a stratum is often a conglomerate changing to sandstone, to be conglomerate again at the bottom of the next. In some places these sandstones are but small remnants clinging to the hillside; at others, where the cross-valleys are wider and shallow, they show far from the foothills, and cover an area of a few miles; but more than 500 feet above the river I have not come across them, though if they were deposited here to the thickness they exist at the Luumbu, they should be found 1000 feet higher, and would not then reach within 1200 feet of the top of the Machinga. Continuing down the river, the same phenomena show—pebble-covered plains, with the certainty almost of the grey limestone beneath, and occasionally harder sandstones on the hillsides—until at 14½° S. lat. the hills close in on the river and form a rather narrow passage, in which no rocks but gneiss and schists are seen. Further down, when the valley broadens out again at the Lusenfwa, and up this and the Mlembo and Lukashashi rivers, still on low ground, the same sandstone and limestone again appear, but in much greater abundance, with the same pebble-covered areas, and with much silicified wood. At the Zambezi, above Feira, I hear are the same rocks; I have not had a chance yet to see. Crossing over from the Lusenfwa westwards towards Tete, I found occasional fragments of the same grey limestone, not much above the Zambezi; and at Tete, as has already been said, the Zambezi flows over a coarse

* I measured the dip at six well-exposed outcrops over a distance of 15 miles, going south-eastwards to the Luumbu, as 15°, 25°, 15°, 12°, 10°, and 10°, with a south-west strike turning to south. Without faulting, a dip of 15° over the distance would give a thickness of over 20,000 feet.

gritty sandstone, which is indistinguishable from that in the Luangwa. Near the sandstones, coal has been found at Tete; it is known near Mount Waller and further north on the Songwe; lately I am told it has been discovered in the Luumbu. It exists in the Lukashashi and Lusenfwa rivers, and there can be little doubt that the sandstones with it are those which contain the coal-seams south of the Zambezi, with some of the Forest sandstones above them; and in the deep valley of the Luangwa they seem to have been deposited when this was a narrow arm of the sea or lake in which all these strata were laid down, and the valley has now been a second time eroded. Among these rocks are none of the interbedded lavas of the forest sandstones of the south, but there are in the Luangwa many copious hot springs, the water issuing at a temperature of 178° to 183°, and having in solution silica and the sulphates of both lime and soda.

Taking a general view of the foregoing sketch, it will be seen that the eastern half of the country is formed of granite and schists, the granite on the east and north being bare, or only occasionally covered by remnants of the schists, while these schists further west are much more abundant, with the granite constantly showing through them. Running through the middle of this area, from north-east to south-west,* is the deep narrow valley of the Luangwa, at the head of which, in the highest land in the country, are the Mount Waller sandstones and the coal-measures of Southern Rhodesia (possibly these are identical) of Permian age; on lower ground lying unconformably † on these are Drummond's Triassic beds; and all down the valley are the remains of more recent rocks, the Forest sandstones, which in the low Zambezi valley overlie the coal-measures and extend into the very high land of Southern Rhodesia.

In the western half of the country are seen—first, in the high land to the north-west, a large area covered by the Tanganyika sandstone in places up to 3000 feet thick, without coal and without lime, separated by nearly 100 miles of granite and schists from the sandstones of the Luumbu, and in what way related to them is yet to be ascertained; next, in the south-east an area of crystalline limestones, much folded, and isolated from the rocks of the east by 50 miles of granite, and bordered apparently on the south by the mass of granite which passes through Kalomo, in North-Western Rhodesia, so that if they are not entirely surrounded by granite, their relation to the other rocks of the country must be found by tracing them round to the west.

Before the paper, the PRESIDENT said: Mr. Wallace, who prepared the paper to be read to-night, is not here; he is in Africa still at his post. He is not unknown to our Society, because some years ago he contributed a very excellent paper on the same region of the world that will be discussed to-night—the Tanganyika plateau. I would especially draw attention to the fact that he for the first time explored Lake Rukwa. Sir Harry Johnston and two or three other explorers had visited Lake Rukwa, but had not explored it. Mr. Wallace at that time was visiting the country for the purposes of shooting and travelling generally. Since then he has become chief surveyor to the British South Africa Company in North-Eastern Rhodesia, and in the performance of his duties he has travelled over this plateau and the surrounding country. The paper will be read by Mr. Otto Beringer, who is

* This is the general strike of all the strata, and it may be noticed that the continuation of the line of the Luangwa valley goes straight up the Zambezi to Wankie's coalfields and to near the Victoria falls.

† Moore.

assistant surveyor in North-Eastern Rhodesia, and who himself has done good geographical work. He has been out there for some fifteen years. Eight or nine years ago he was working for the African Trans-Continental Telegraph Company, and in doing so he ran a line of survey from Nyasa by Tanganyika up to Lake Victoria, and he produced for our *Geographical Journal* an admirable map of the country he passed through. I ought to say that the map now in your hands and a more elaborate map which will appear in our *Journal* are practically the work of Mr. Beringer himself.

After the paper, the PRESIDENT said: Mr. Beringer has read us a most interesting paper, and I rise to propose a vote of thanks to both himself and the writer of it. That paper closes with a reference to the Geodetic Survey. We have present with us to-night Sir David Gill, the astronomer royal to the Cape for the last twenty-seven years. Last spring the Geodetic Survey stood in great risk of coming to a standstill in British territory, but Sir David Gill came to the front, and with extraordinary energy, and largely through Sir George Darwin in this country, funds were raised—I may say our Society contributed—and the Geodetic Survey in British territory went on, and no doubt will be completed.

Sir DAVID GILL: I was not aware that I should have to speak to-night, and had I been a right-minded official I should have insisted on notice. Not being a right-minded official, I will endeavour to say a few words, and, in the first place, to thank Mr. Beringer for his excellent account of the history of the Geodetic Survey in Northern Rhodesia. The fact that one year of the work was given to the Boundary Survey, of which there was immediate need, naturally robbed the Geodetic Survey of one year's work, and the famine and the other difficulties which arose certainly hindered very much indeed. There were other causes, which I need not enter into, which have led to the non-completion of the work within the three years which it was originally estimated to require. So far the measurement of the arc of meridian has been carried up to lat. 11° 30′ S., that is to say, to about here (indicating on map), and there is only that little bit to do to take it up to Lake Tanganyika. Perhaps I may be excused if I point out what are the great objects of this geodetic work. It was commenced in 1883, carried through Cape Colony and Natal; from Natal it was carried through the Transvaal and the whole of the Orange River Colony. It is complete to the Limpopo, and again it was resumed here in the neighbourhood of Gwelo. Why this gap arose was the fact that it was necessary, for the purposes of the British South Africa Company, to make a part of the triangulation not purely a part of the geodetic arc, because they desired the survey to begin near Bulawayo, in connection with the survey of the mining areas. Accordingly the triangulation in Rhodesia was first carried from Bulawayo eastwards to Gwelo and Iron Mine, and then Mr. Rhodes decided that it should go northwards to the Zambezi, and afterwards onwards to Tanganyika, promising that if the Transvaal did bring their triangulation along the 30th meridian from Natal to the Limpopo (a work not then begun), he would undertake to fill the gap from Gwelo to the Limpopo. When the survey of the Transvaal had reached the Limpopo, and survey operations in the Transvaal were on the point of abandonment, it seemed most desirable, before the surveyors were dismissed, to complete the little gap between Gwelo and the Limpopo. I may say that the Chartered Company at first said, "No, we have done our share; we have done enough." I wrote to various people in England, trying to get them to press the directors of the Chartered Company, and I admit they have been very good indeed, and they said, "We ought to be helped in this great scientific matter." Sir George Darwin took the matter up, and coaxed the British Association, the Royal Geographical Society, and the Royal Society, and several private individuals to give

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(a) Outline edition in 12 sheets, water in blue. Size about 20 × 13 inches. On paper	1 0	
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3. Ireland, engraved. Latitude and longitude marked.		
(a) Outline edition. Size about 36 × 27½ inches. On paper	2 6	
(b) Hill shaded edition, printed from a transfer from copper, with hills in brown, roads sienna, and water blue. On paper	2 6	
Ditto. Mounted on holland, and bound with blue ribbon. Price 5s.; or with moulding and roller, 10s.		
4 miles to 1-inch Scale.		
4. England and Wales, engraved in black, latitude and longitude marked, no hill shading or contours. Size 22½ × 15 inches. On paper	1 6	
5. England and Wales, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 22½ × 15 inches.		
(a) On paper	1 6	2 0
(b) On thin paper, folded in cover or unfolded	1 6	
6. Scotland, engraved. Printed from a transfer from copper, with water in blue, latitude and longitude marked, no hill shading or contours. Size 18 × 12 inches. On paper	1 0	
7. Scotland, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 18 × 12 inches.		
(a) On paper	1 0	
(b) On thin paper, folded in cover or unfolded	1 0	1 6
8. Ireland, engraved. Printed from a transfer from copper, with water in blue. Size 18 × 12 inches. On paper	1 0	
9. Ireland, engraved. Printed from a transfer from copper, hills in brown, roads sienna, water blue, woods green. Size 18 × 12 inches		
(a) On paper	1 0	
(b) On thin paper, folded in cover or unfolded	1 0	1 6
10. County and District Maps of Great Britain, cheap edition, roads in brown, latitude and longitude marked, on thin paper or folded in cover. In sheets. Unmounted. 6d. and	1 0	
Folded in cover. 9d. and	1 0	
2 miles to 1-inch Scale.		
11. England and Wales, photo-etched on copper. Printed from a transfer from copper, hills and contours in brown, principal roads burnt sienna, woods green, water blue, latitude and longitude marked. Size 18 × 12 inches.		
(a) Folded in cover or unfolded	1 0	1 6
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* New series in large sheets. Size 27 × 18 inches. Folded in cover or unfolded	1 6	2 0
1-inch Scale.		
12. England and Wales, outline, contours in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0	

* Publication in progress.

	Price per sheet. On paper. s. d.	Mtd. on linen. s. d.
13. England and Wales, hills hachured in brown, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0	
14. Ditto, hills hachured in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0	
15. Ditto, hills hachured in brown, contours red, roads sienna, water blue, woods green (on revised edition), magnetic variation shown, latitude and longitude not marked. Size 18 × 12 inches. On thin paper, either flat or folded in cover. Single sheets	1 0	1 6
Combined sheets	1 6	2 0
New Series in Large sheets. Size 27 × 18 inches. Flat or folded in cover (in course of preparation)	1 6	2 0
16. Scotland, outline and contours in black, latitude and longitude marked. Size 24 × 18 inches. On paper	1 6	
17.*Ditto, hills hachured in brown or black, with black contours, latitude and longitude marked. Size 24 × 18 inches. On paper	1 6	
18.*Ditto, hills hachured in brown, contours red, roads sienna, water blue, woods green, magnetic variation shown, latitude and longitude not marked. Size 24 × 18 inches. On thin paper, either flat or folded in covers	1 6	2 0
19. Ireland, outline, not contoured, in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0	
20. Ditto, outline, not contoured, in black, latitude and longitude marked, showing county, rural, urban, and county borough boundaries in red. Size 18 × 12 inches	1 0	
21. Ditto, hills hachured in black, latitude and longitude marked. Size 18 × 12 inches. On paper	1 0	
22. Ditto, hills hachured in brown, roads sienna, water blue, woods green, latitude and longitude not marked. Size 18 × 12 inches. On thin paper, either flat or folded in cover	1 0	1 6
23.*Combined maps of areas round certain large towns, or other areas, such as the New Forest and Lake District, and published in various forms and sizes. These maps usually show outline and contour in black and roads in brown. In sheets, unmounted	9*d.* to 1 6	
Folded in cover	1*s.* to 1 6	
6-Inch Scale.		
24. Great Britain, water coloured blue or back lined, contours in black, latitude and longitude marked. Heliozincographed or photozincographed. Size 18 × 12 inches	1 0	
Engraved or photozincographed (where not published in quarter sheets). Size 36 × 24 inches	2 6	
25. Ireland, engraved or heliozincographed, contours in black, latitude and longitude not marked. Size 36 × 24 inches	2 6	
$\frac{1}{2500}$ Scale.		
26. Houses ruled in black, water blue or back lined, latitude and longitude not marked. Size 38 × 25½ inches	3 0	
27. Houses red, water blue, roads brown, latitude and longitude not marked. Unrevised editions only coloured in this form. Size 38 × 25½ inches. From 2*s.* 6*d.* to 23*s.*, according to the amount of colouring. This form is gradually being superseded by 26.		
Town Scales.		
28. $\frac{1}{500}$ scale, houses stippled. Size 38 × 25½	2 6	
29. Ditto, houses ruled. Size 38 × 25½	2 6	
30. Ditto, houses red, water blue, roads brown. Size 38 × 25½ inches. From 2*s.* 6*d.* to 15*s.*, according to the amount of colouring. Applies to unrevised only.		
31. 5-feet scale, houses stippled. Revised. Size 36 × 24 inches	2 6	
Index Maps.		
32. Indexes to the sheets of the 1-inch scale maps of England and Wales, Scotland, and Ireland, scale 30 and 27 miles to an inch. Sizes about 18 × 13 inches	0 2	
33.†Index to the sheets of the 6-inch scale map, parishes coloured. England and Wales. Size 18 × 12 inches	1 0	
Scotland. Size 24 × 18 inches	1 6	
34.†Index to the sheets of the 1 : 2500 scale map, parishes coloured. England and Wales. Size 18 × 12 inches	1 0	
Scotland. Size 24 × 18 inches	1 6	
35. Nos. 33 and 34 are identical with Nos. 12 and 16, but with sheet lines added, printed on thin paper, and coloured to show civil parishes.		

* Publication in progress. † Publication stopped.

us £800, and the Chartered Company promised to give me pound for pound, and said, "You must complete it for £1600." Well, I hope we shall. Captain Gordon is hard at work upon this bit, and he says unless he is eaten by lions he thinks he will get through. I want to point out what a tremendous thing this will be. When we have got to Cairo, we have only to go round that little bit of the Mediterranean, and that carries the work directly to Struve's arc on the 30th meridian from Turkey up to the North Cape, so that we shall have a complete arc of 105°, the longest arc measurable on the face of this globe. It is a very great work, a work of extreme importance to geodetic science, and, of course, of extreme importance to geography. We shall have this backbone of solid triangulation sure and certain within the accuracy that man is capable of obtaining as a basis for all future map work, which will relieve us from those tremendous uncertainties which too often beset the work of travellers and map-makers. I ask for the sympathy of you all, and of the Geographical Society, in helping me to get this great work completed. I may add that the work has already been begun under Captain Lyons in Egypt, and that the British Government has already started the work of reconnaissance for a part of the arc immediately north of Lake Tanganyika. The Berlin Academy of Sciences has already approached the German Government, urging that the work be taken up through German East Africa from north to south of Lake Tanganyika, and so joining the British work about to be commenced north of Tanganyika. It is, therefore, of the utmost importance that the arc be carried from lat. 11½° S. to the southern end of Lake Tanganyika. I won't promise you that I shall never come back and ask the Royal Geographical Society for more money. But I may say the British South Africa Company owes a debt to the promise and the memory of its great founder, Cecil Rhodes, who said to me, "I will see that arc of meridian carried out." And although they have responded nobly, I am sure we shall do all we can to help them, and I hope they will not consider that all their responsibility is already fulfilled.

The PRESIDENT: I think we might now hear the Chartered Company. Sir Lewis Michell is here to-night, whom you all know by name as having been, I forget for how long, the guiding spirit of the Chartered Company in London.

Sir LEWIS MICHELL: I am not going to detain you with a long speech to-night, but I think we are very much indebted to Mr. Wallace for having prepared this very interesting paper for us. Personally, I am always glad to acquire information, or to see my friends acquire information, and more especially is that the case when the information relates to any portion of that vast empire which we are sometimes accused of having built up in a fit of absence of mind. The portion dealt with to-night is quite an outlying post of the empire, and almost unknown; but thanks mainly, I think, to the members of this Society, the Dark Continent is dark no longer. It perhaps was never so black as it was painted. But, in any case, it is now getting less dark than it was; the clouds are rising and the shadows are vanishing, and we shall soon know all that is to be known about the heart of Africa. I dare say many in this room will remember the interest with which they read the memorable books of Stanley, in which, amongst other things, he talked with the greatest respect of that mysterious river the Luapula, and here to-night comes Mr. Wallace and talks of the Luapula as if it were a mere ordinary waterway, like the Thames at London Bridge. And this persistence in travel is what is gradually contracting the horizon of Africa, and making us in this country know all about it. Now, I venture to think that the time is approaching when the portion of Northern Rhodesia which has been dealt with to-night will prove of very great value. In the first place, I notice that Mr. Wallace dwelt very rightly upon the fact of its being high plateau land. Now that, I think, is of

enormous importance. It would be criminal to tempt people from this country to go to the malarial swamps and rivers of some portions of Africa. But a country that possesses thousands of square miles of high plateau land in the heart of Africa is a very valuable possession indeed, and the day will come when the inhabitants of these crowded isles may be glad to go to a country like that and make it their home. That was the dream of Mr. Rhodes's life. What will finally induce them to do so is not for me to say. I should not like to hint that it may be caused by the pressure of the rates, but in any case we may reasonably expect that before many years are over that elevated plateau which extends over almost the whole of Rhodesia, both north and south of the Zambezi, will be populated by white inhabitants. I believe that the settlers will gradually acquire what Mr. Rhodes called "more homes" there, and in that way the territory in the long run will be of inestimable benefit to the mother country. With regard to the Geodetic Survey, I do not feel at all qualified to speak, especially after the astronomer royal at the Cape has spoken to you to-night. I will, therefore, only say this—that the Chartered Company in its various surveys has altogether spent a matter of between £25,000 and £30,000, and it has done its best to forward the objects which scientific men like Sir David Gill have so much at heart. We have played our part, we have done our best so far as means will permit, and I hope Sir David Gill will live to see that arc of the meridian fully surveyed and determined.

The PRESIDENT: I will now call upon Mr. Wilson Fox, who, as secretary of the Chartered Company for many years past, has been more closely connected with Rhodesia than any living person since Mr. Rhodes's death.

Mr. H. WILSON-FOX: I feel I may claim your indulgence this evening if I say a few words, because, during the many years I have been a constant attendant at these meetings, I have never previously had the honour of addressing you.

I will not attempt to speak to you about these extraordinarily interesting rivers, plains, swamps, and mountains which Mr. Wallace and Mr. Beringer have had the good fortune to visit. The only reason I wish to say a few words to-night is this. I am most profoundly impressed with the great work which is carried out by men like my friend Mr. Wallace. All of you who have had the honour of meeting him will know that he is one of the most modest, one of the most unassuming, and, at the same time, one of the most clever and earnest workers in the field of geographical research. Mr. Wallace and Mr. Beringer are daily engaged in doing this work, with the assistance of a large staff of willing helpers. These helpers are men whose names none of you will probably ever hear. Most of them are district officers, who with their compasses or their plane-tables are filling in the gaps of the British Empire. Their work is typical of the work which is making this great Empire. It has been the most interesting thing to me year after year to watch the process of filling in the gaps in the maps, which at one time were covered with only a few dotted-in rivers, but which now are gradually assuming form, and one begins to speak quite familiarly of places of which a few years ago one had never heard. That, I think, is great work, and it is not the least important work of the British South Africa Company with which I have the honour to be connected. That company in a few short years has carried forward quietly and successfully a policy of which we hear a good deal elsewhere in Africa, but not always with the same results, a policy of peaceful penetration. The chartered territories have neighbours on two sides which are governed by the methods of Crown Colony government. Now, I do not wish to be severe on Crown Colony government, but I must state the fact that in no Crown Colony territories which are adjacent to Rhodesia is there a single mile of railway or telegraph which has not been constructed through the instrumentality of the British South Africa Company. The British South Africa Company has had to supply

both the railways and the telegraphs for the neighbouring territories as well as for its own. That is a significant fact, and one on which we should all do well to ponder. Then with regard to this matter of the Geodetic Survey. I can only hope that Sir David Gill—and, if I may say it without offence, he is a sturdy beggar—will be as successful with the Imperial Government as he has been with the British South Africa Company. And, as Sir David has given away the secret history of his negotiations with the Chartered Company, I should like to add one fact he has omitted, and that is that after inducing the directors to put pound for pound into the survey, he still was not satisfied. He immediately wrote a letter asking if they would not carry the men and the stores for the survey free on the railway. I hope Sir David will apply these methods to the Imperial Government, and with the same success.

The PRESIDENT: I will now ask Mr. Goode, the secretary to the North-Eastern Rhodesia Administration, to say a few words, because he has lived on the spot.

Mr. GOODE: It is a great pleasure to have had the opportunity of hearing Mr. Wallace's interesting paper read at this meeting, and to join in the appreciation of the record of scientific work already accomplished in North-Eastern Rhodesia by Mr. Wallace, and those who have assisted, in the direction in which so much practical and stimulating encouragement has always been received from your Society. We hope soon to be able to add to the information available about the topography and geology of the country, the results of the Geodetic Survey, which, as you have heard, owes its inception to Sir David Gill, to whom we in North-Eastern Rhodesia are so much indebted in many ways for ready help and kindly advice. North-Eastern Rhodesia is proving itself a locality of singular interest also in its natural history. Mr. Neave, who was attached to the Geodetic Survey as naturalist and spent two years in the country, has been able to obtain a very large and excellent series of specimens of mammals, birds, fishes, insects, and so forth, which will be seen at the Natural History Museum and the Manchester Museum. In reference to the prediction made by Mr. Wallace in his paper that in the dense patches of the tropical forest some species would be found belonging to the forest country of the Congo, I think it is very interesting to know that among the collection of birds brought home by Mr. Neave there were several distinct West African species totally unexpected by the authorities of the Natural History Museum. When the account of Mr. Neave's work is published, I feel sure that it will be clearly shown that there is a great field for further discovery in this direction. From the figures given by Mr. Wallace in his paper, it must be strikingly evident that certain districts of the country are extremely sparsely populated, and, considering the large area of the territory, the total population is small, so small almost as perhaps to give ground for reasonable doubt as to the possibility of the population being able to supply sufficient labour for future industrial development. I think, however, that this smallness of population may be attributed in no small measure to the comparatively recent unrestricted and sanguinary activity of certain predatory tribes, such as the Angoni and the Awemba, and to the decimating ravages of small-pox. Under a sympathetic administration, there is no doubt the population is now steadily and in some cases rapidly increasing. Relieved from the fear of home attacks, the young and enterprising native of some position can now start out and make a new village for himself with merely the small nucleus of his own family and perhaps a few dependents. This is occurring in some districts almost daily, and it has exercised and must continue to exercise a very stimulating effect on the birth-rate. Small-pox, though it is impossible to say that it can be utterly stamped out or exterminated, is controlled by Government measures, and can never claim the number of victims

it used to claim in the days before the establishment of the Chartered Company's administration. I am afraid I have nothing of any scientific value to add.

The PRESIDENT: I do not know if any Fellow present would like to address the Society; if not, I will put the vote of thanks I proposed to both the reader and writer of the paper.

IRRIGATION IN THE UNITED STATES: ITS GEOGRAPHICAL AND ECONOMICAL RESULTS.

By JOHN H. BEACOM, Major U.S. Army.

SCIENCE, in all probability, made its first great contribution to the wealth of nations by creating oases in the desert.

Under the influence of scientific irrigation, the barren plains drained by the Tigris and Euphrates became so wonderfully productive that for many generations they constituted the richest possession of the Powers that swayed the East—of Nebuchadnezzar, of Cyrus, and of Alexander. Opis, Bagdad, Ctesiphon, Selucia, and Babylon grew up in these valleys and became famous for their wealth and luxury. But all these cities, with the exception of Bagdad, perished long ago, and the plain on which they stood is again a desert. A similar fate befell the cities of Seistan and of many other places that were dependent upon irrigation.

If we turn from Asia to the so-called New World, we find remains of irrigation works that were as well built, as extensive, and as old as those we have mentioned; and apparently the people who manned them were as numerous and as prosperous and, in the end, as unfortunate as those who dwelt by the Tigris or the Helmand.

It would be interesting, and not wholly out of place in a paper on this subject, to consider how man has been affected by the conditions of life in irrigated districts—by its certainty as compared to the uncertainties in the life of the agriculturist who looks to the wandering clouds to water his land; by its fixity, its narrowness, and its monotony. But is it not evident, without going very deeply into the history of irrigation, that such an environment would tend to make a man less self-reliant? Would it not unfit him to resist the inroads of men from the mountains or from the waterless plains where the precarious conditions of life develop courage and individuality? Would it not in time unfit him to resist the encroachments of the desert, which, like man, is ever anxious to add to its dominions?

I have no doubt that, if the history of the great irrigation areas in Asia Minor, Turkestan, India, Egypt, and in the western parts of North and South America were fully known, we should discover some interesting parallels in the history of the peoples who became masters and then slaves in those widely separated regions, and that we should be justified

in concluding that the conditions surrounding the irrigation-agriculturist are bound in time to convert him into a serf.*

We may not all be of one mind as to the influence of irrigation on society, but we all know that the spirit of the desert has been able frequently to again make desolate large areas which for a long period of time man has made to yield an abundant harvest. We know, also, that the various peoples who to-day inhabit such remnants of these ancient systems as are still irrigated are all under a species of bondage to men who have developed under a totally different environment.

Whatever the cause, there is no doubt that agriculture by irrigation was on the wane for many centuries both in the old and the new world. But now suddenly there has come a great awakening, and schemes more comprehensive than those of Nebuchadnezzar or the Pharaohs of the Twelfth Dynasty are to be carried out in this wonderful moment of time in which we are living.

In the valley of the Nile there are projects affecting regions lying thousands of miles above the Delta of that river. In northern India some millions of acres are to be added to existing areas under irrigation. It is even proposed to renew the struggle with the desert in Asiatic Turkey and Seistan. In the United States and Canada they are building works to irrigate larger areas than are under irrigation in any of the above-named countries.

And who is it that is doing all this? Is it a people that have been sitting by irrigating ditches for some centuries? Not at all. It is the great wandering race—the Anglo-Saxon.

Of all these great schemes, we are specially concerned to-night only with those that lie within the limits of the United States.

Irrigation and drainage, while designed to remedy evils that are opposite in character, have the common object of adding to the agricultural area of the country, and both are now coming very much to the front in America. It is estimated that as large an area can be reclaimed by drainage in the humid regions east of the 100th meridian of longitude as can be reclaimed by irrigation in the arid and semi-arid regions west of that meridian. Moreover, the density of population and the price of land in the eastern half of the country has reached the point where irrigation, notwithstanding the humidity, begins to pay just as it has done in some of the humid districts of Europe. Consequently, in the eastern half of the country, both irrigation and drainage will receive considerable attention during the coming years, but I shall confine myself to the irrigation areas of the arid and semi-arid states, and shall consider drainage only as a necessary adjunct to irrigation.

A century ago it was generally believed that the semi-arid and arid

* See pp. 8 and 9, 'Tibet and Turkestan,' by Oscar T. Crosby. Published by G. P. Putnam's Sons.

plains stretching far to the east and to the west of the Rocky mountains were unfitted for the habitation of man. It was believed that the tide of emigration, which was then moving westward from Europe, might eventually reach the eastern edge of this so-called desert, but could proceed no further; but so many were the men that came with that tide, and so great was their hunger for land, and so liberal were the provisions of Government for acquiring it, that in a few years they had crossed the Alleghany mountains, the Mississippi and the Missouri rivers, and were beginning to invade the so-called desert that lay some distance beyond. As the hardy pioneers in this movement advanced farther and farther, the greater were their difficulties, and they finally reached a point where the generosity of Government was counterbalanced by the difficulties imposed by nature. Government then passed a series of laws designed to strengthen the hands of the settler in his struggle with nature.

As some knowledge of the various land laws is necessary to a proper understanding of the situation in the arid and semi-arid regions where the Government is now carrying out its irrigation projects, I shall give a brief outline of them.

The Homestead Law.—This is the law under which the title to most of the land west of the Alleghanies which is now held by individuals was first acquired. It provided that any person who was the head of a family or twenty-one years of age, and a citizen of the United States, might enter upon 160 acres of public land and acquire title thereto by paying five shillings an acre and residing thereon for five years.

The Timber Culture Law.—This law was passed in 1873, and was designed to promote tree-culture in timberless areas by giving title to 160 acres of land to the head of a family, provided he would plant 10 acres of timber on this tract, and keep it in a healthy growing condition for eight years. This law was repealed in 1891.

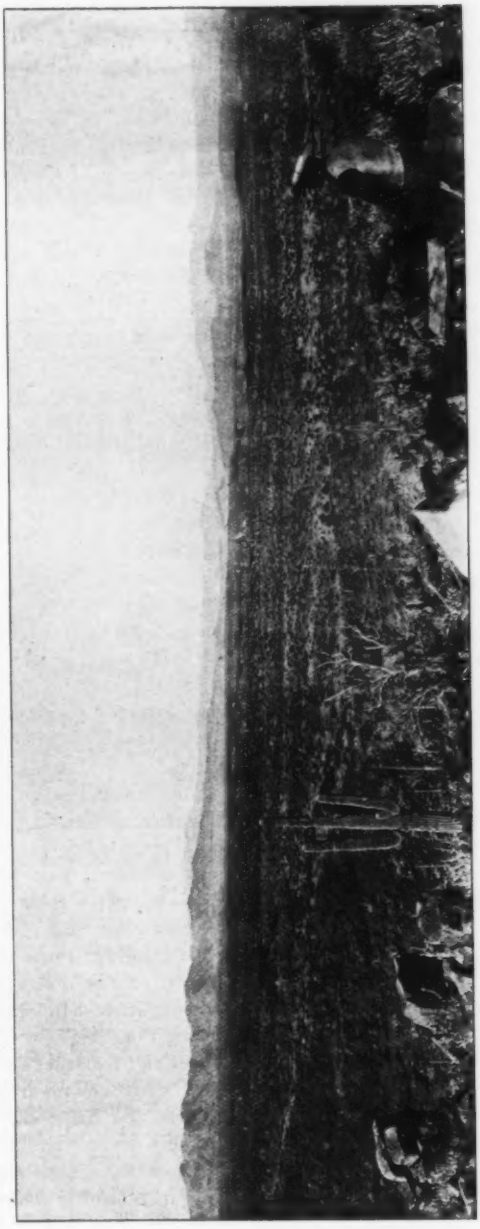
The Desert Land Act of 1877.—This law provided that the head of a family, or any person twenty-one years of age, and a citizen of the United States, by paying in advance a shilling an acre, and declaring that he would reclaim the land by conducting water upon it within three years, might enter upon 640 acres of land classified as desert land. But before a patent was given him for this land he had to show that he had spent at least twelve shillings an acre in the irrigation, reclamation, and cultivation thereof; and in addition thereto he had to pay four shillings an acre, making a total of seventeen shillings an acre. In 1891 this Act was amended, limiting the entry to 320 instead of 640 acres.

Under this Act considerable semi-arid land was reclaimed, but it did not meet all requirements. What was needed was a law that would favour large irrigation projects which require the investment of much capital.

Transfer of Arid Lands to the Several States.—The next step taken by

Congress in support of irrigation was in 1894, when a law was passed providing for the transfer to each of the states "Such desert lands within the state, not exceeding 1,000,000 acres, as the state may cause to be irrigated, reclaimed, occupied, and not less than 20 acres out of each 160-acre tract, cultivated by actual settlers within ten years after the passage of the Act."

The Reclamation Act. — But the most important of all the Acts of Congress affecting irrigation was the Reclamation Act, which was passed on June 17, 1902. As most of the great irrigating schemes to which I shall have occasion to refer were made possible by this Act, I shall give it somewhat in detail. It provided that all moneys received from the sale and



SALT RIVER PROJECT, ARIZONA. DESERT AS THE GOVERNMENT ENGINEERS FOUND IT.

disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming, on and after July 1, 1900, should be set aside as a special fund in the Treasury, to be known as the "Reclamation Fund," to be used in the examination and survey for, and the construction and maintenance of, irrigation works for the storage, diversion, and development of waters for the reclamation of arid and semi-arid lands in the above states and territories. The Secretary of the Interior was made the administrator of this fund, and he was authorized to make examinations and surveys for irrigation works, and to locate works for the storage, diversion, and development of waters, including artesian wells. He reports to Congress at the beginning of each regular session as to progress made in this direction.

The entryman upon lands to be irrigated by such Government works must comply with the Homestead Law, must reclaim at least one-half of the total irrigable area of his entry for agricultural purposes, and before receiving a patent for the land, he must pay to the Government, in ten or less annual instalments, the charges that have been apportioned against the tract. The area of each entry shall be such as, in the opinion of the Secretary of the Interior, may be reasonably required for the support of a family, and the charges per acre shall be the estimated cost per acre of the project.

The Government, wishing to prevent the acquirement of large areas by individuals and the possible absenteeism of owners, provided in the law that "No right to the use of water for land in private ownership shall be sold for a tract exceeding 160 acres to any one landowner, and no such sale shall be made to any landowner unless he be an actual *bonâ fide* resident on such land, or occupant thereof residing in the neighbourhood of said land."

It was further provided "That when the payments required by this Act are made for the major portion of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby, to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior: Provided, that the title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided for by Congress."

It further stipulated that "The right to the use of water acquired under the provisions of this Act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right."

The funds derived from this law have now reached the sum of £6,400,000 sterling, and the annual increment is about £800,000.

If we glance back over these several laws, we see that three of them relate directly to irrigation :—

(1) That of 1877, known as the Desert Land Act, which granted to the settler 640 acres of desert land if he reclaimed it within three years.

(2) That of 1894, granting to each of the arid and semi-arid states 1,000,000 acres of desert land, provided the State caused it to be irrigated, reclaimed, and occupied within ten years.

(3) That of 1902, known as the Reclamation Act, by virtue of which the general Government undertakes the construction of large irrigation works, and also the management of them until they can with

CEMENTED CUTTING TO PREVENT WATER FROM RUNNING AWAY UNDERGROUND.

safety be turned over to the people who have acquired a right to the beneficial use of the water which these works supply.

These three laws show how rapidly the irrigation idea grew in magnitude and importance. Under the first, success depended upon the capital and energy of the individual; under the second, each of the arid states became interested; while by virtue of the third, which was passed only twenty-five years after the first, the general Government becomes the leader and director of the larger enterprises.

The amount of land that had been put under irrigation by private and State enterprise up to June 30, 1900, amounted to 7,263,273 acres, and the cost of construction of the irrigation systems was £13,000,000. The amount under irrigation at the present time is 10,000,000 acres,

and the works have cost £18,500,000. With this as our datum point, we may now proceed to consider some of the Government projects; but first let us consider—

The Extent of Country to which the Reclamation Law applies.—The sixteen arid and semi-arid states constitute about half of the area of the continental part of the United States, or about 1,500,000 square miles. Much of this vast area is sufficiently humid to require no irrigation. Much that requires irrigation in order to become productive can never be reclaimed for lack of sufficient water in the lakes and rivers, or because of the engineering difficulties to be overcome in conducting water over it; but, according to the estimate of conservative engineers, it will be possible to reclaim about 50,000,000 acres in addition to the 10,000,000 already reclaimed.

Some idea of the extent of this reclaimable area may be gained by comparing it with the area in the United Kingdom under crops of all kinds, including hay, which, in 1904, was a little over 19,000,000 acres, or about one-third of the area of the desert lands that have been or will be reclaimed in the United States by means of irrigation. If we consider the great productiveness of an acre of irrigated land as compared with an acre of non-irrigated land, we see that this will be adding very largely to the agricultural domain.

In British India (exclusive of Burma, Beluchistan, and the Native States) there are about 45,000,000 acres under irrigation, which is an increase of about 11,000,000 in the last twenty-five years. Of this total area, about 19,000,000 acres are irrigated by State works, and about 26,000,000 by private works. The present programme provides for new State works that will add about 6,000,000 acres, thus bringing the total for India proper up to 51,000,000; but it will be several years before this programme can be completed. A portion of this area is not remunerative, but its protective nature in famine years justifies the Government in maintaining the works.

In all Egypt there are 5,538,000 acres under irrigation, and each year liberal allotments of funds are made for the study of vast schemes for the storage and control of the waters of the White and Blue Nile, with a view to the eventual irrigation of millions of acres of land in that part of the Nile valley, and to increasing the area of irrigation on the lower Nile as well.

Machinery for carrying out the Provisions of the Reclamation Act.—Shortly after the Reclamation Act was passed, a Reclamation or Irrigation Service was organized as a section of the Geological Survey, which is a subdivision of the Interior Department. The engineers belonging to this service investigate all irrigation projects, and report to the Secretary of the Interior; if he approves the project, the engineers then prepare detailed plans for the works, and proceed with their construction, or the secretary may let the work to contractors, in

which case the engineers act as inspectors to see that the work is properly carried out.

Twenty-four projects have already received the approval of the Secretary, and on all of them the work of construction has begun. The names and location of these projects, with the amounts already allotted to them, the approximate cost of each project when completed, and the acreage to be reclaimed by them, are shown in the following table:—

Location of project.	Name of project.	Amount allotted and to be allotted this year.	Estimated cost of completed project.	Acres to be reclaimed.
		£	£	
Arizona	Salt river ...	791,123	791,123	175,000
Nebraska-Wyoming	North Platte ...	684,270	684,270	100,000
Montana	Huntley	184,937	—	30,000
„ and N. D.	*Lower Yellowstone	390,243	390,243	66,000
„	Milk river ...	205,486	—	100,000
Oregon	Klamath	410,973	821,946	240,000
„	Umtilla	205,486	205,486	20,000
California-Arizona ...	Yuma	616,459	616,459	85,000
Nevada	Truckee-Carson ...	616,459	1,849,378	400,000
Idaho	Minidoka ...	267,132	—	130,000
„	Payette-Boise ...	267,132	1,849,378	372,000
Colorado	Uncompahgre ...	513,716	513,716	100,000
Washington	Okanogan ...	102,743	102,743	10,000
„	Tieton	205,486	—	24,000
„	Sunnyside ...	154,114	—	40,000
Wyoming	Shoshone	462,344	462,344	75,000
South Dakota ...	Belle Fourche ...	431,521	554,813	85,000
North Dakota ...	Pumping Projects	205,486	—	80,000
Utah	Strawberry valley	256,658	—	50,000
New Mexico ...	Hondo	49,316	49,316	10,000
„ „	Carlsbad	123,292	123,292	15,000
„ „	Rio Grande ...	41,057	1,479,503	180,000
Kansas	Garden city ...	53,426	53,426	8,600

These works include a great variety of engineering problems: the construction of large dams and long tunnels, the leading away of rivers from their natural channels into the valleys of other rivers, the sinking of many wells and providing machinery for lifting their waters to the canals, etc. The country in which these works are located extends through 19° of latitude and embraces a wide variety of climate, and in planning the works all this must be borne in mind. In California or Arizona, for instance, the engineers must allow for the excessive evaporation, while on the Yellowstone, in Montana, they must protect the dams against ice gorges. A hasty glance at the more important features of a few of these projects, will give us some idea of the engineering questions that arise.

The Salt River Project in Arizona.—This involved the construction of a dam across the cañon of Salt river at an almost inaccessible point

* The "Lower Yellowstone" consists of two projects.

about 60 miles above Phœnix, and before commencing work on the dam, it was necessary to hew a roadway for several miles along the face of the wall rock of the cañon. When completed, the dam will be only 800 feet long on top, and 235 feet at the river-bed; but it will rise 284 feet above its foundations, and support a column of water 230 feet high. It will contain 1,400,000 acre-feet of water, which is more than

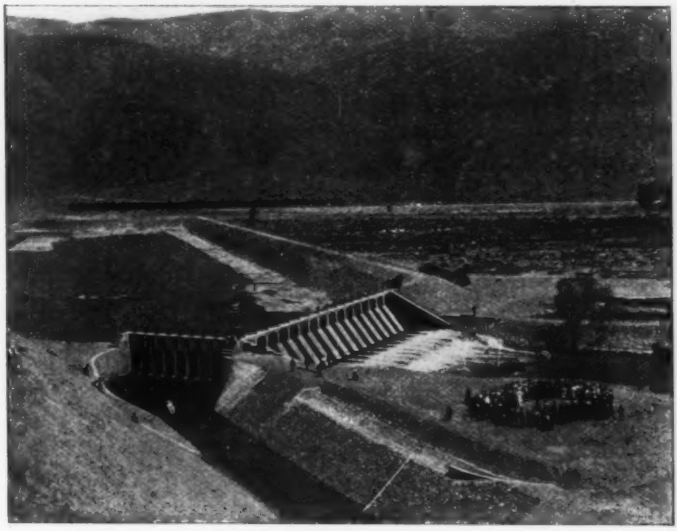
SKETCH-MAP OF THE WESTERN UNITED STATES, SHOWING IRRIGABLE AREAS.

is held by the great dam at Assouan. Ten thousand horse-power will be developed from the dam and from drops in the canals, and this power will be utilized to pump the underground water of the valley to lands that lie above the gravity systems. The area irrigated will be about 175,000 acres, and the entire project will be completed in 1909.

The Soshone Project in Wyoming.—This is very much like the Salt

river project in some respects, but it is much smaller, as it will irrigate only about 75,000 acres. It involves the construction of several miles of difficult roadway up the cañon of the Soshone, and the locking of this cañon by a dam 310 feet high. This makes it the highest dam in the world, I believe, but it is only 200 feet long on the top, and 85 feet at the base.

The Uncompahgre Valley Project in Colorado.—The Gunnison river in Colorado flows for a considerable distance through a cañon approximately 2000 feet deep, and with almost vertical walls. It would not be very difficult to lock this cañon; but a dam, even of the height of



DAM ACROSS CAÑON.

the one on the Soshone (310 feet), would come far short of lifting the waters to the level of the adjacent lands. But not far away, at a much lower elevation, lies the valley of the Uncompahgre, and the engineers discovered that, by building a low dam in the cañon of the Gunnison, and boring a tunnel through the wall rock, the waters of the Gunnison could be brought into the Uncompahgre. This is now being done, and the combined waters of these two rivers will be utilized to irrigate about 100,000 acres of exceedingly fertile land lying in that valley. The tunnel has a cross-section of $10\frac{1}{2}$ by $11\frac{1}{2}$ feet, and will be nearly 6 miles long.

The Truckee-Carson Project in Nevada.—This was the first irrigation work undertaken by the Government. It is more comprehensive, and

will require a greater outlay, than any other scheme that has so far been approved. It involves extensive storage-works on Lake Tahoe, the turning of the waters of Truckee river into Carson river, the construction of a large reservoir on the latter river, and the utilization of the waters of all rivers that now flow into Carson sink and are evaporated. The great dams required on the Truckee and Carson rivers, and the main irrigation canals leading from these, were the first works completed by the Reclamation Service, and they were formally opened on June 17, 1905, the third anniversary of the passage of the Reclamation Act. This scheme will reclaim about 400,000 acres of land that was formerly worthless desert, but which, when once reclaimed, will be worth £6,000,000. The Government expenditure will be nearly £2,000,000, and this must be supplemented by large expenditures on the part of the settlers before reclamation will be complete.

The Projects on the Yellowstone River in Montana.—There are two projects on the Yellowstone. The works of the lower one are about 19 miles below Glendive, and those of the upper or Huntley project are near Billings. The dams are being constructed in both cases with special reference to preventing the formation of ice-gorges, which sometimes cause much damage on this river, and with this end in view, they will be timber-covered, and the curved face will be downstream.

The Klamath Project in Southern Oregon and Northern California.—The Klamath valley contains three large lakes—Upper Klamath, Lower Klamath, and Tule or Rhett lake; but when the engineers have carried out their plans only the Upper Klamath will remain.

The Lower Klamath is to be drained by cutting a canal through the natural dyke which preserves its present level, and its exposed bed will be divided into farms and irrigated. Tule lake will be eliminated, but by a different process. This lake receives its entire supply of water from a river—very properly called the Lost river—which wanders about in a confused way for some 60 miles, and finally arrives at a point only 6 miles from where it started. This river is to be dammed, and its waters drawn off to irrigate lands lying in the valley, and, as a result, Tule lake will dry up, and its bed will then be irrigated. In all about 240,000 acres will be brought under irrigation, and at a cost of only about £3 10*s.* per acre, which is the lowest estimated cost of any of the Government projects. The engineering questions involved are of the simplest nature, and yet the character and appearance of all that part of the Klamath valley will be completely changed.

The Rio Grande Project in New Mexico.—The project has been approved, but the work of construction has scarcely begun, as the allotment is very small. The cost of the entire project will be about a million and a half sterling, and about 180,000 acres will be irrigated, but it will probably be several years before the works are completed. The main

feature of the project is the construction of a great dam by which a reservoir will be formed having a capacity of 2,000,000 acre-feet.

Irrigation has been carried on in this district for a long time, and a good many disputes have arisen between the people of New Mexico and Texas concerning their respective water rights, and some controversies, not easy of adjustment, have arisen between the United States and Mexico over similar questions; but in the allotment of the waters of this great reservoir the Government will endeavour to compose all these difficulties.

The Payette-Boise Project in Idaho.—This is a large project, as it

LOOKING DOWN THE TRUCKEE CANAL THROUGH ONE OF THE ROCK CUTS.

provides for the reclamation of 372,000 acres, at a cost of about £1,800,000. The flood waters of the two rivers, the Payette and the Boise, are to be stored, and as the Payette has more water than is required to irrigate the lands naturally tributary to it, and as the Boise has not enough, the surplus waters of the Payette are to be diverted into the valley of the Boise. The soil in this district is excellent, and the climate such as to admit of a wide variety of products.

The Yakima Valley Project (including the Sunnyside and Tieton sub-projects) in Washington. — The Yakima river has its source on the eastern slope of the Cascade mountains, and flows in a south-easterly direction until it empties into the Columbia some distance above Walla Walla. There are about half a million acres of land in this valley that

could be irrigated if the supply of water were sufficient, but the Government engineers estimate that storage cannot be developed for more than 300,000 acres.

The proposed system is an extensive one, consisting of the following sub-projects: the Ledbetter (210,000 acres); the Sunnyside (40,000 acres); the Tieton (24,000 acres); and the Kettitas (60,000 acres), and it is found that each of them can be treated as a separate unit. So far only two of them have been approved—the Sunnyside and the Tieton.

There is an irrigation system already in operation at Sunnyside, but this has been purchased by the Government, and will be made a part of the more comprehensive system. The purchase of existing systems is contemplated wherever Government ownership will facilitate the full development of the larger scheme as planned by the engineers, and a number of small works have been purchased already. The estimated cost of the entire system is £2,500,000.

Pumping Projects.—The first pumping project to receive the approval of the Government is the one at Garden City, Kansas, where water sufficient to supply 8600 acres will be drawn from the underground supplies. There will be twenty-three pumping stations, each driven electrically from a central power station.

In North Dakota four pumping projects have already been approved, and they provide for the irrigation of about 80,000 acres. Both steam and electric power will be used, and the lifts will range from 40 to 80 feet. Power will be developed from lignite, which is found in great abundance in the vicinity of the stations.

There are projects on three rivers—the Platte river, Milk river in Montana, and the Colorado—to which I wish to refer, not only on account of their engineering features, but also on account of the legal questions involved.

The *Platte river* has two main branches, both of which rise in Colorado. The South Platte flows direct from Colorado into Nebraska, but the North Platte passes through Wyoming before it enters Nebraska. Each of these three states has its own laws governing the right to the waters of streams within its borders, and is inclined to ignore the rights of those living on the same stream but in another state.

In order to remove the many causes for dispute in such cases, the Government is making a very thorough investigation of the laws and institutions relating to the use of water both at home and abroad, and it hopes before long to establish an equitable system of distribution. The river Platte is taken as a good example of an interstate stream, and it is being studied very carefully to determine the effects of diversion from one section of the stream upon the flow in lower sections of the stream, as it is necessary to know just what becomes of diverted water in order to determine to what extent diversions may be made without interfering with the rights of people and states farther down-stream. Moreover,

the Government is building a reservoir on the North Platte capable of storing more than a million acre-feet of water, which is intended to irrigate 100,000 acres of land lying partly in Wyoming and partly in Nebraska, and it is necessary to know just what effect this will have on lands already under irrigation.

The river has been divided into sections, varying from 1 to 50 miles in length, with an observation station at each end of each section. Careful measurements are made of the discharge at the upper station, of the inflow and of the diversion between the upper and lower station, and of the discharge at the lower station, and thus the gain or loss for

POWER SITE JUST BELOW THE NORTH PLATTE DAM SITE, LOOKING DOWN CAÑON.

the section is determined. These measurements have been taken for some years, and will continue to be taken until it is fully determined just how much of the water used for irrigation returns to the river by seepage, and how long it takes it to get back.

Some general conclusions can be drawn from the data already at hand relating to the Platte river. (1) That much of the water taken from the river eventually returns. (2) That if the water be carried some distance from the river, it may require years for it to return. (3) That irrigation areas on the lower stretches of a river may be benefitted by having the water of the river drawn off on the upper sections, as it may be returned just in time to increase the flow in the lower sections at the time of year when water is most needed.

The Milk River Project.—Legal questions similar to those arising in the Platte valley are involved in the Milk river project, but their settlement depends, not on inter-state, but on international comity.

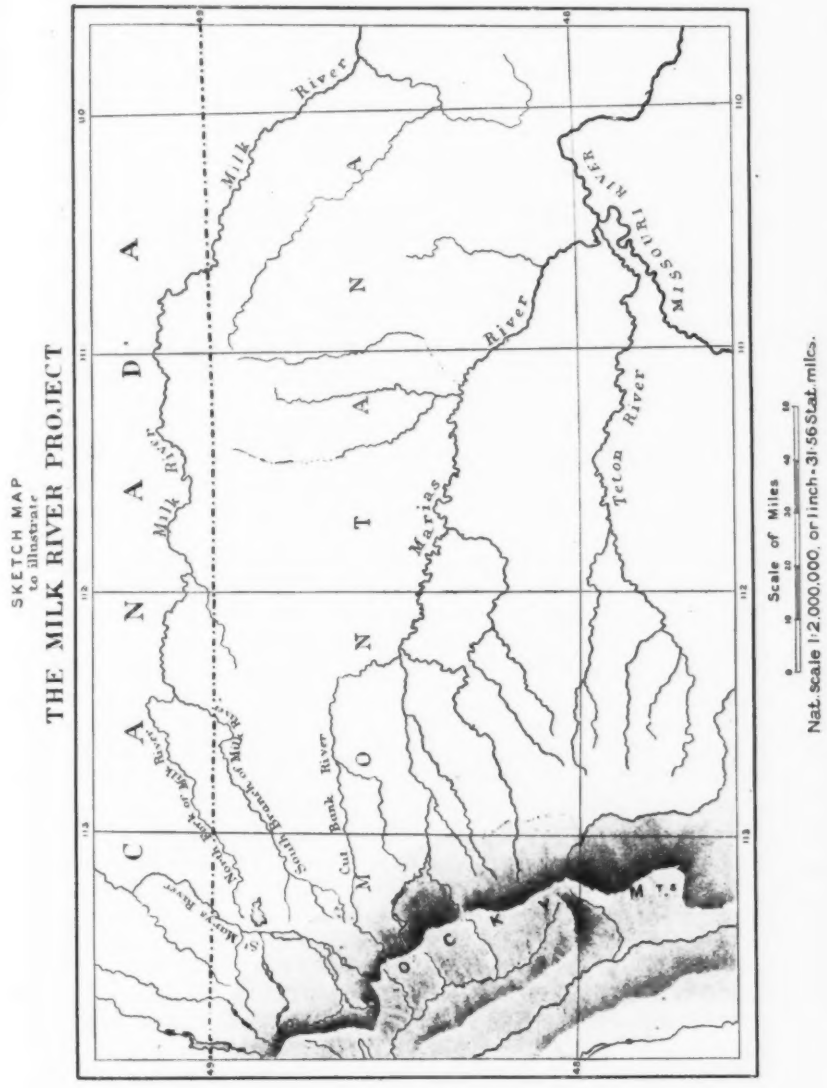
The situation is about as follows: Two rivers, the St. Mary's and Milk river, rise in Montana on the eastern slope of the Rocky mountains, and a little south of the international boundary-line. The St. Mary's is a mountain stream, and on issuing from the mountains it runs north, crosses the boundary-line, and finally reaches Hudson bay.

Milk river is a prairie stream, having its source only a little way east of the St. Mary's river, and it also flows north into Canadian territory, but after wandering through that country for about 150 miles, it returns to the United States, and its waters finally reach the Gulf of Mexico.

Several years ago some enterprising Canadians (who happened in this instance to have gone from the United States) took up land on the lower St. Mary's, and began to irrigate it, and they were so successful that a company is now building works on that river that will irrigate several hundred thousand acres.

In the valley of Milk river, in Montana, there are also many thousands of acres of rich land awaiting irrigation, but there is not enough water in that river to meet the requirements of such a large tract. In fact, the small areas that are already under irrigation are threatened by the large works projected on that part of the river which lies in Canada. To make good this shortage, the engineers of the Reclamation Service proposed some years ago to build a dam on the St. Mary's river 50 feet high, and to cut a canal through the low divide separating St. Mary's river from Milk river, and thus divert as much of the water of the former into the latter as might be required for the irrigation of 100,000 acres lying along its lower stretches. They believed that the addition to the stored waters of the St. Mary's river resulting from the building of this dam would permit this to be done without interfering with existing diversions from these rivers in Canada or Montana. Then there arose between the American and the Canadian a great discussion as to what parties are entitled to the use of the waters of a stream. The Canadian argued that St. Mary's river had been flowing through its present channel to Hudson bay for thousands of years, and that no one had a right to divert it to another channel and another sea. The American answered that the heavens first deposited these waters on American soil, and that the owners of that soil had a right to the use of them. The Canadian then declared that if these waters were diverted into Milk river, he would draw them all off when that river entered Canada, and that they would never get back to Montana. Then the American declared that, instead of diverting the waters into Milk river, he would lead them into the Cut Bank river, which flows into the Marias, and thence on to the Missouri, without ever passing into

Canadian territory. And so the discussion goes on, and will continue to go on until an equitable allotment of these waters is provided for by



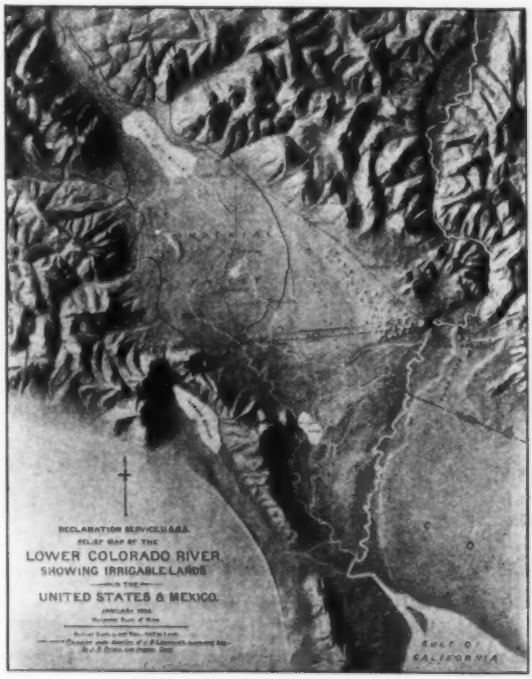
treaty. Such a treaty is being drawn up, I believe, and let us hope that its provisions will satisfy all parties concerned.

The Colorado River.—The region drained by this river has double the area of the United Kingdom; its lofty mountains, its grand cañons, its desert wastes, and its many other natural wonders give it a peculiar interest. In elevation it ranges from 12,000 feet above sea-level to 300 feet below sea-level; climatically it extends from Sweden to Egypt; its southern portion, both in soil and climate, is *very much* like Egypt; and its great river resembles the Nile in many respects; both are flood rivers, and in their lower stretches flow through a semi tropical and practically rainless desert, and each has formed a great delta, which it overflows and enriches annually. I do not know what the calculations are as to the amount of silt and detritus carried by the Nile, but it is stated on excellent authority that when the Colorado is in flood it carries 1,500,000 tons past each point south of the grand cañon every twenty-four hours. No wonder that in the course of ages it has made its mark in the world; that it has cut a great cañon through the mountains several hundreds of miles in length, and in many places a mile deep. It carried all this material, almost incalculable in amount, down from the mountains, and built up a great plain with it, and at the same time it built a great dike or highway for itself well above the level of that plain. When it reached the Gulf of California, it kept on with its building scheme until it formed a great bar clear across the gulf, thus cutting it in two. The northern arm of the gulf, when once cut off from the sea, gradually disappeared, as the inflow of fresh water was not enough to overcome evaporation, and its bed finally became a great sunken salt desert; then each year the river overflowed its banks, and some of these salts were washed down to the lowest parts of the depression, and on the slopes a layer of rich sediment was deposited.

It was only a few years ago that man began to meddle with this situation: he began to take salt from the great deposit at the bottom of the depression; he made an opening in the bank of the river, and by the aid of its waters converted the slopes into very productive farms; he built a railway through the valley to transport the salt from the mines, and the various products from the farms to the markets; and in a few years what had been known as "Colorado Desert" acquired the name of "Imperial Valley." All went well for a time, but unfortunately the engineers of the irrigation scheme had not reckoned with the Colorado river. They put no permanent headworks in the canal; and one day in 1905, when the river was in flood, it enlarged the canal opening, and greatly increased the amount of water drawn off by the canal, and it kept on increasing it until now nearly the entire Colorado is discharging into this ancient sea-bed, and a fresh-water lake is being formed. The salt works have already been destroyed, and the railroad has been compelled to move to higher ground. The engineers are struggling with the mighty task of turning the river back into its old channel, but as this new lake, this youngest child of nature, is already 60 miles long

and several miles wide, and is growing rapidly every day, it may be that the 80,000 acres of irrigated land will be submerged, and the eight or ten thousand people who live in the valley will be driven from their homes before the engineers shall have succeeded in their undertaking. Mexico, as well as the United States, is interested in the outcome, as the lower portion of the delta is Mexican territory.

It is estimated that 1,300,000 acres of land are so situated that Colorado river waters could be used on them, but the amount of water



required for such an area is much more than the river can furnish at its low state; it will be necessary, therefore, to store the flood waters in order to increase the supply at the season of minimum flow. Reconnaissances already made show that below the grand cañon no reservoir sites exist, and that suitable places for storage of the flood-waters of this river and its tributaries must be sought higher up at points a thousand miles or more above the delta, but some years of study and investigation will be required before the problems involved in this great scheme can be solved. These problems are not unlike those of the Nile, but the

Colorado has no great natural reservoirs such as the Nile has in Lake Victoria and Albert Nyanza.

In the lower portion of the Colorado valley there are three important irrigation areas—

Private enterprise, as we have seen, has put 80,000 acres under irrigation in Imperial valley.

The Government project on Salt river, already referred to, provides for the irrigation of 175,000 acres more.

Another Government project, known as the Yuma, will irrigate 85,000 acres lying in Arizona and California. A great dam, nearly a mile long, will be thrown across the Colorado river about 12 miles above Yuma. As it will rest on a bed of sand, it will depend on its mass for its stability. It will have a length up and down stream of 267 feet, with a height of only 19 feet; and there will be two canal systems, one on either side of the Colorado, with headworks at opposite ends of the dam. The waters of the canal that has its headworks at the eastern end of the dam will be carried under the Gila river, which flows into the Colorado a few miles below the dam, by means of a siphon of steel and concrete about 3300 feet long. This great length is necessary on account of the great floods on the Gila, and the consequent changes in the channel. The Gila and the Colorado both overflow their banks in this region, and it will be necessary to build levees on both sides of them to protect the irrigated land from inundations.

These three projects—the Imperial valley, the Yuma, and the Salt river—will irrigate about 250,000 acres. If we add to this the smaller areas already under irrigation, or to be put under irrigation in the near future, we have a pretty large district, and one of great potentiality. The soil is very fertile, and the climate is so hot and dry nearly all the year round, that, with the aid of irrigation, it is destined to become the garden spot of the continent. Many tropical and semi-tropical plants that cannot be grown in other parts of the country will grow luxuriantly under these new conditions. The palm tree and many bits of old-world landscape will be reproduced here, and a few years hence it will be possible for the Arizona farmer to recline under his vine and fig tree and read his Bible amid a real Bible-land environment.

The process of converting a desert into a productive farm consists of three stages—

(1) The construction of the irrigation works.

(2) The preparation of the land to receive the water.

(3) The selection and cultivation of the plants.

The Secretary of the Department of the Interior, as we have seen, is responsible for the construction of the works; but from that point on, the success of the enterprise depends mainly upon the man who has settled on the desert land. But he is not left to work out his salvation alone and unaided, for at this point in the process the Secretary of the

Department of Agriculture steps in, and by his aid and advice assists the settler to carry on the undertaking to a successful conclusion.

This latter official is charged with the supervision of all public business relating to agricultural industry, and more than a million pounds is allotted annually for carrying on the work of his department. This is a large sum, but very little when compared with the value of the farm products of the country, which now amount to the "unthinkable aggregate" of more than a billion pounds sterling annually.

A fair portion of the money expended each year by this department is devoted to irrigation investigations, with a view to protecting the

A HOME NEAR PHŒNIX, ARIZONA, SHOWING THE EFFECT OF IRRIGATION IN THAT REGION. SALT RIVER IRRIGATION PROJECT.

great capital which, as a little calculation shows, will be invested in this business.

The charge against each acre reclaimed is about as follows :—

	£	s.		£	s.
For construction of works	from 3	10	to	10	0
For clearing away sage brush, etc.	„ 0	6	„	1	0
For levelling the surface	„ 0	4	„	3	0
For laterals and diversion boxes	„ 0	4	„	3	0
Total initial cost per acre ... ... „	4	4	„	17	0

If we take £10 as an average, we find that the aggregate cost of

reclaiming 50,000,000 acres would be £500,000,000, or twenty times the cost of the Suez canal.

It is evident that the really poor man cannot become an irrigation farmer, for, in addition to the initial cost per acre, as shown above, there is the necessary outlay for buildings, machinery, and tools, and the cost of seed and water for the first crop. Neither can the stupid man afford to embark in this business, for, with such a costly plant, a series of mistakes would prove disastrous.

As the Government constructs only the irrigation works, there are many things for the settler to do before he is ready to sow the seed for his first crop. He must clear the ground of sage brush or other rubbish; he must level it so that a proper amount of water can be applied to all parts of it, and he must construct the necessary laterals and diversion boxes. To an old hand these are comparatively simple matters, but to any one new to the business they seem very complex and difficult. Most of the men who are now entering upon these lands come from the humid regions where conditions are very different, and, although intelligent as a class, they know little about these matters. To minimize their mistakes the Government has issued a "Farmers' Bulletin," which explains, in clear and simple English, the different methods employed in this preliminary work, and gives photographic reproductions and drawings of the implements required.

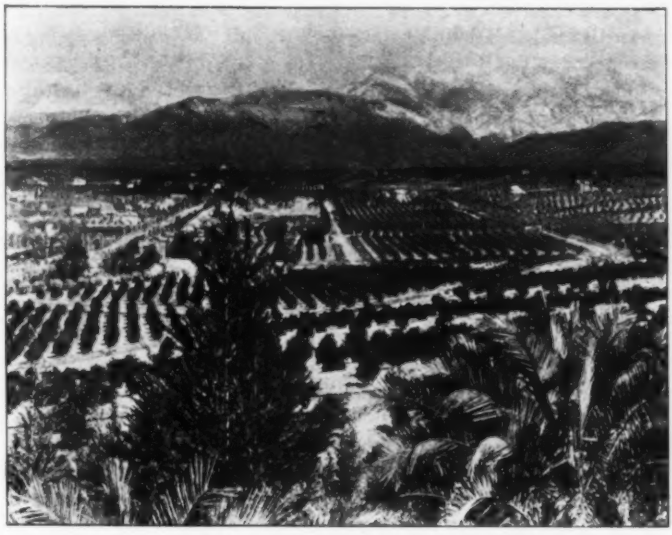
Having prepared the land in accordance with the instructions in the bulletin, the next thing for the irrigation farmer to consider is the best method of applying the water to his particular crop, and he finds in this same bulletin many suggestions. The various systems are discussed—the check system, flooding from field ditches, the furrow system, and the basin method—and the advantages and disadvantages of each are pointed out.

But even if the farmer makes no mistakes in any of these things, his land may still be rendered valueless by conditions arising from irrigation, but over which he, as an individual, has little or no control, and it is therefore necessary for the Government to look after his interests.

In India and other irrigation countries, and in the United States as well, large areas of once productive land have been abandoned because of the rise of alkali, or in consequence of swampage caused by seepage from the over-watered higher-lying lands and from the canals. The low-lying ground receiving the seepage soon becomes saturated at some distance below the surface, and the plane of saturation gradually rises until water is so near the surface as to kill vegetation, or it may rise above it. This rising ground-water brings with it usually the soluble salts of the soil, and these are deposited on or near the surface as the water evaporates. In order to avoid these results, it is necessary, in certain situations, to have a drainage system in connection with the irrigation system. But to establish a proper drainage system requires

the co-operation of many owners, and considerable engineering knowledge, and for this reason the Government experts have taken the matter in hand, and either plan a drainage system in connection with the irrigation system, or give advice as experts when it becomes evident, later on, that drainage is necessary. These experts are now experimenting with alkali lands in irrigation areas with a view to ridding them of excess salts, and excellent results are attending their efforts.

As a result of Government aid and advice in these various matters, the losses to the farmers will be much less in the future than they have been in the past.



COMMUNITY OF SMALL IRRIGATED FARMS IN SOUTHERN CALIFORNIA, WHERE THE ANNUAL INCOME NETS APPROXIMATELY $1000 PER ACRE.

The Third Stage.

But the construction of irrigation works and the preparation of the land to receive the water are all preliminary to that more interesting question, the selection and cultivation of the living plant; and here, as elsewhere, we find that the Government is able to give us excellent suggestions.

In 1862 and 1890 liberal grants were made to the various states and territories in support of institutions giving instruction in agriculture, and, as a result, there are now sixty-three such institutions, and almost every one of them maintains an agricultural experiment station. The Department of Agriculture supports stations of its own in Alaska,

Hawaii, and Porto Rico, but the home work is carried on mainly by these state institutions with which the Department is in constant communication. It suggests new experiments, co-ordinates the work of all the stations, and in some cases lends them financial aid. In return it gets the results of their investigations, which it publishes along with those of its own stations and of similar institutions abroad. By means of many trials at these stations, it endeavours to ascertain the best treatment for the various kinds of irrigated soils, and to determine the grains, grasses, fruits, and vegetables best adapted to each soil and climate; also the amount of water needed to produce the best results, the time when it should be applied, and the methods of application best suited to different localities and different crops—and through the medium of its widely disseminated bulletins the farmer gets the benefit of all these experiments.

One of the most interesting bureaus of the Department of Agriculture is that of plant industry, the function of which is the study of plant life in all its relations to agriculture. It maintains, among other things, a laboratory for plant-breeding, an experimental garden, and an experimental farm, and one of its many duties is that of selecting and importing new seeds and plants.

Every year America receives many immigrants of one kind or another —human beings, animals, and plants—more than a million in all. Comparatively little care is taken in the selection of the immigrants belonging to the genus homo, but when it comes to animals and plants, especially the latter, a great deal of care is taken to get only the best. To accomplish this the Bureau of Plant Industry keeps a corps of agricultural explorers travelling up and down the world looking for plants superior to those already under cultivation in the United States, or new plants which these experts think would grow there and be profitable. As a rule, about half a dozen new things arrive every day, and with them, or more often preceding them, comes a report explaining their habits and their habitat, so that arrangements may be made for sending these plant immigrants to that part of the country which is most likely to furnish them a congenial home. Upon arrival, they are passed on to the experiment stations of the various states, or are entrusted to expert farmers who may be depended upon to give them proper care and attention.

Among the more successful species that have come from abroad may be mentioned the olive from Southern Europe; the orange from Eastern Brazil; the tomato, the potato, and the Lima bean from Peru; the rhubarb from Central Asia; the celery from Southern Europe; and the asparagus from England.

Among the more successful of the recent introductions into the regions we are considering, is the durum wheat of Southern Europe and Russia, which is found to be very well suited for the dry lands of the

semi-arid states. This is the wheat from which macaroni is made, and the acreage devoted to its cultivation is increasing so rapidly that the hopeful American expects before long to be shipping macaroni to Italy.

A hardy Swedish oat capable of resisting a great amount of drought has been established in Montana, the Dakotas, and neighbouring districts, and is giving excellent yields.

The Vladimir cherry and forms of the Siberian crab-apple have been brought from Siberia, and introduced into the cold regions of the north-west.

Alfalfa is another of the successful immigrants. Varieties have been found that withstand the rigorous winters of the north-western prairie states; other varieties have been found in the alkali districts of Algeria and Turkestan, and these are being cultivated in similar districts in the south-west, and it is expected that large areas now useless on account of excess alkali will be reclaimed.

For the fertile oases that irrigation is creating in the lower Colorado desert, many things are being imported. Berseem, a variety of clover, from Egypt, the fig-tree from Smyrna, and many varieties of date palm from Egypt and from the oasis of Biskra, in Sahara. A species of alfalfa has been found which, on these rich slopes, yields six or seven crops in the course of the year, aggregating from 10 to 15 tons per acre.

Much of this "Great American Desert" is to be reclaimed, but it is not by irrigation alone that this will be brought about, but by the introduction of hardy plants that have proven themselves able to hold their own against the desert in other parts of the world, and by the careful breeding and nourishing of these plants so that they will be able to do even more in America than they have done elsewhere.

Not many years ago much of this vast region was a grazing-ground for millions of buffalo, deer, and antelope, and a hunting-ground for those wild children of the plain—the Indians; but the white man came, the ambitious white man, and in a little while nearly all forms of the old animal life had disappeared. They were succeeded by a creature a little less wild and a little less attractive, but still attractive, the cow-boy; and now he is almost extinct, and is being supplanted by that very tame and very prosaic individual, the man with the hoe. Those of us who had the good fortune to see something of that freer and wilder and more generous life of the plains before the advent of the irrigating ditch, find in the recent and prospective changes much to be regretted. But, on the other hand, much has been gained; the productivity of tillable areas has been greatly increased; desert stretches have been converted into fields of waving grain, and millions have been added to the taxable wealth of the nation. In view of all this, I think we should be content.

Before the paper, the PRESIDENT: I have to introduce to you to-night the reader of the paper, Major Beacom, who is military attaché to the United States embassy.

Our Society has always maintained close relations with both the naval and military members of that embassy, which has been fortunate in obtaining a succession of able men to fill those posts. Major Beacom has had the advantage—a great advantage to all geographers—of seeing active service outside his own country in the Philippines, and he has always taken a great interest in this question of irrigation. He will give you to night what I know to be a most interesting account of the effects produced by irrigation on those arid regions of the Western United States, which were in former days regarded as irreclaimable deserts. The subject is one of high interest to all geographers, but it is, I think, of special interest to us, because it is a question which largely affects the future of considerable portions of the British Empire. An immense work in this direction has been done, as we all know, in India, which fortunately possesses a government independent of the struggles of parties, and so has been able to conduct its work efficiently. Much has also been done in Australia, where our colonial brothers are free from the fetters of mediæval modes of thought. So again, as we all know, the ancient irrigation of Egypt has been vastly extended under the wise autocracy of Lord Cromer. But there is one part of the British Empire where not only the economic future, but also the political future, depends largely on the thoroughness with which a policy of irrigation is carried out. I am referring, of course, to the new colonies of the Transvaal and the Orange River Colony, to which must be added a considerable portion of Cape Colony. Our own rulers at home have not carried out any very lasting or consistent policy with regard to this matter, and this is not surprising when one considers the feeling of almost disdain that so many people in this country, otherwise highly educated, have for geography; for I need not point out to you that irrigation over vast regions is strictly a geographical question, depending as it does upon the morphology of the country, on the political conditions, and on the nature of the soil. I think that it will be very agreeable to hear a paper on this subject delivered by a citizen of a very go-ahead and progressive country, in which geography is considered to be a proper subject for the education of youth. I will now call upon Major Beacom to read his paper.

After the paper, the PRESIDENT: I think we must open the discussion by calling upon Sir Colin Scott-Moncrieff to say a few words. He is, as you know, not only the highest authority in India, but the highest authority in Europe on the question of irrigation in many parts of the world.

Sir COLIN SCOTT-MONCRIEFF: May I be allowed first to say what pleasure I have in welcoming a brother officer from the American corps of Engineers in this country? I am sure my brother Engineers present will join me in saying so. Major Beacom has given us a most interesting lecture. One little thing he remarked was curiously unlike my own experience: he said parts of the Colorado had reminded him of the Nile in Egypt. Now, it struck me the whole position was as unlike the Nile as anything I had ever seen, not only as regards the country, but among the *genus homo* to whom he alluded. As I listened to page after page with great interest, I kept asking myself questions which I would like to ask the lecturer; but if I asked them all it would keep you here at least till midnight. He told us a great deal; but he knows, as well as any one else, that there was a great deal he had not time to tell us. I would like to ask where all this great water-supply comes from; whether it is a certain supply or not; whether in that country they have great famines owing to drought, such as we have in India; and whether they raise grain at all without irrigation? In Egypt there is no halfway house; there is merely irrigation or the desert. Major Beacom alluded to the small area of land that was irrigated in Egypt; but it is all there is of Egypt—there is no land there that is not irrigated. The country of Egypt is about one and a half

times the size of Wales. It would take eight Egypts to make Great Britain, and out of that you cannot make a large field for irrigation. When I talk about Egypt I do not mean the desert on the two sides, because they are no more Egypt than the sea is. In Egypt everything is grown by irrigation, because there is practically no rainfall to speak of. Therefore, you cannot have famines from want of rain, and there is no famine so long as the Nile is properly managed. In India it is very, very different. There is a certain amount of rainfall, which is all that a great part of the country has to depend upon; and it is sufficient for the commoner style of crops, but not for the more valuable ones. And there irrigation comes in; and then the question comes, How much water is there, and can you count upon it? In Northern India there is a great ice-wall, and the hotter the day the more the melted ice comes down, rolling over the country. Further south there are large reservoirs, great lakes doing valuable work; but when the rains fall, as they sometimes do, these lakes are empty. I remember having experience of it in 1877, in a beautiful fertile province, Mysore, where the reservoirs number some 30,000, I believe, and there was not a drop of rain in one of them. I do not know if in America that kind of thing can happen; whether the rivers ever fall short of water, or whether there is a constant supply. Reservoirs go a long way, but any scheme of irrigation requires a large volume of water. You will be perhaps surprised to hear that a million cubic feet of water will not keep more than about 7 acres of rice alive. One great point we always have to consider with regard to an irrigation officer in India, is what use he makes of his water. An officer is put in charge of a certain amount of water, and he is asked, "How many acres have you irrigated out of it?" He keeps an exact account of the volume of water that enters and the quantity that leaves his division, and he has to send in an account showing that so many cubic feet of water have irrigated so much land. I do not know whether it has come to that, or whether there is the necessity for it, in America. If there is plenty of water, there is no great need to trouble about it. Major Beacom alluded to the large area—45,000,000 of acres—in British India. I should say that of that 45,000,000, 13,000,000 are irrigated from wells. These wells are made by the private farmers and peasants; they are often merely holes cut in the ground down to the spring-level. Sometimes—not in most cases—they are lined with masonry. The Government has nothing to do with them, but it gives a man an advance to help him to dig a well, and it is afterwards entirely his own; and for this irrigation the Government can take no credit. What has been done by Government is not much more than 30,000,000 acres. I believe there is going to be a great deal more. I was struck, but not more than I expected to be, with the courage and with the magnificent engineering works of the American engineers. The difficulties they have had to face were enormous, and the works are evidently of a very high order. One would like to hear a great deal more about them, and, of course, most of all to visit them. One great difficulty that exists in India is the soil. A large portion of the country is composed of what is known as "black cotton soil;" it is very clayey, and a very small amount of rain will produce a crop. Very much rain will make a quagmire, and you can get nothing much out of it; but with moderate rain it is especially good for cotton. My chief business in India for many years was considering the question of irrigation always from the point of view of the prevention of famine, and, coming to a district of black cotton soil, the people would come and say, "For Heaven's sake, don't send your water here." And that would go on for perhaps ten years, and then they would come and go down on their knees, and say, "For goodness' sake, give us water." The difficulty is the financial question, because if people only want water once in ten years, you cannot see how to charge them. My experience of

irrigation has always been with subject people, either the natives of India or the natives of Egypt, and they at least are totally unlike the natives of America. With these subject people there is a strong Government, and you lay down rules which the people must obey. For instance, a distributing channel delivers water to the first 3 miles on Monday, Tuesday, and Wednesday, and to the next 6 miles on the other half of the week. The irrigator has a little earthen pipe inside the channel from which he draws his water, and if he is caught irrigating his crop on one of the days on which it ought not to be irrigated, he is fined; and this law they can keep pretty well enforced. I do not know that the American farmer would be as amenable to reason if he saw his crop dying? I do not want to say anything against Boer farmers, but from what one has read, I do not think they are very good at obeying the law. The conditions with regard to water in the Transvaal are very curious. It is a limestone formation, and there seems to be a regular network of rivers or branches of rivers some 40 or 50 feet below the ground. A farmer sinks a well, starts a pump, and he may pump dry a dozen farms all round him. While he is injuring the neighbours, he may have far more water than he wants for himself; but he says, "I bored the well, and I am entitled to all the water." Laws must be made for such cases as this, and these laws must be rigorously enforced. The most law-abiding and the most scientific irrigators I know are in North Italy; they have had irrigation from the time of Leonardo da Vinci. They have a beautiful system of canals, and there the farmers are law-abiding; and I have been told it is considered as disgraceful to take water out of your turn as to steal a horse out of a stable. I hope it may be the same in America. I was much interested in the efforts that are being made in America to study agriculture and see what is best for the different soils. I am sorry to say we are very much behindhand in that respect, both in India and in Egypt. The total initial cost of these American projects, we are told by Major Beacom, is from £4 to £17 per acre. In India the average is about £3 5s. per acre, but there are no works like these tremendous works we have seen photographs of to-night.

The PRESIDENT: I will now call upon Prof. Gregory, who, during his long experience in Australia, must have gained a great deal of information connected with the irrigation there.

Prof. GREGORY: I should like to join Sir Colin Scott-Moncrieff in expressing the high appreciation in which the work of the Irrigation Department of the United States is held in other countries. The great collection of data obtained by that department, not only throws light on many problems of high theoretical interest, but is of great practical value to those who in other countries are wrestling with drought, and trying to stay the deplorable waste of water in times of flood. We must thank Major Beacom for his interesting account of the work at present in progress in the United States. It is interesting to observe in how many respects Australia and America are developing their irrigation schemes on parallel lines; sometimes the one state and sometimes the other is the pioneer. The United States is, of course, working on much greater lines; but its Reclamation Act, providing for great national schemes, conducted by a branch of the Geological Survey of the United States, follows the much earlier example of Victoria, where the great reservoirs and long water-channels are all State works, made and managed by a branch of the Mines Department. So far as Australian practice is concerned, there seem to be three main requirements in successful irrigation: the water is wanted at the right season, and, as Sir Colin Scott-Moncrieff pointed out, a great deal of it is wanted; the population should be concentrated, at least locally; and there must be a considerable population of painstaking and careful farmers. Irrigation work has the great advantage that a desert soil is, in most cases, a fertile soil. There are, of

course, exceptions; but in the majority of cases the old desert soils have stored up such accumulations of plant food that they only want water to grow luxuriant crops. The Milk river controversy is analogous to that between three Australian states over the Murray. South Australia contributes nothing to the waters of the Murray river, all of which comes from New South Wales and Victoria. Canada may get some encouragement from the Australian decision, as the two states that supply the water agree to allow South Australia a very considerable share of it.

The PRESIDENT: I will ask Mr. Colquhoun if he will say a few words. He is an old South African, and knows large parts of the world.

Mr. COLQUHOUN: The subject of the paper read this evening is one that is of special interest to myself, although I have not had the opportunity of personally visiting these irrigation works of which Major Beacom has given us so interesting an account. There is, perhaps, no more eloquent tribute to the energy and enterprise of the American people than these irrigation works, and it is wonderful to-day to realize that the enormous areas of land, which not very many years ago were wild and almost trackless, are now so fully peopled and so far developed, that it is necessary to begin the undertaking of these reclamation schemes with a view to intensive cultivation later on. The special point to which I venture to call your attention this evening, is one which came under my notice in South Africa in connection with this question of irrigation. Major Beacom has incidentally referred to the great difficulties that arise from the existence of water rights in old countries; but he has not said so very much on this particular subject, because in new regions, such as the one he has been treating of, these difficulties are not accentuated in the same way as they are in the older and more peopled countries. In Italy, as Sir Colin Scott-Moncrieff has partly indicated, this particular difficulty (which was very acute indeed, arising from the conflicting interests of that country) was met by what may be briefly called the nationalization of the water rights, and, in the opinion of many people who know South Africa, it will be necessary for that country to follow the example of Italy, if the full possibilities of South Africa as an agricultural country are ever to be realized. The United States are to be congratulated on having such a wonderful organization—an organization which combines so complete a scientific study with the practical enterprise which the American people always exhibit. We ourselves in India have a department, as our chairman has told us this evening, which has done not only such wonders for India, but has helped to recreate Egypt, and has sent most distinguished irrigation engineers to nearly all parts of the world to report upon that subject, and Sir Colin Scott-Moncrieff, who is with us this evening, is perhaps the most distinguished of these engineers. But there are two countries within the British Empire, one South Africa, and the other Australia: South Africa, which has hardly begun to think of irrigation; Australia, which has done something, but by no means what ought to have been done for that great country—these two seem still not to realize the value of really scientific irrigation. It is, therefore, of the greatest value to us, and fraught with interest also, to hear of the methods which are being adopted in the United States, where scientific study is so happily combined with practical energy and enterprise. And I hope that our young democracies overseas, those within the British Empire, may see their way to follow the example of our American cousins in this respect, if not perhaps in all others.

Mr. BUCKLEY: At this late hour I feel I must not detain you long, but I should like, in concert with Sir Colin Scott-Moncrieff, to congratulate Major Beacom and the Engineers of America on the great progress they are making in the science to which so many of us in India have devoted our lives. Major Beacom referred to the great Colorado river, and there is one point in connection with that which may be of some

interest to the meeting. The great Colorado river carries down, Major Beacom told us, 1,500,000 tons of silt every day in a great flood. Now, perhaps you will all think that this mud in the water is not a very important matter. I assure you that it is important. In India it is a common thing to see a cultivator, who has got his ricefield filled up by the rain, deliberately letting off the rain-water, and then, when the field is dry, allowing the canal water to flow over it again. You ask him why he does it. He tells you it is because he gets fertilizing silt from the water. It is the fertilizing silt which has made Egypt so fertile, and it is fertilizing silt which will keep the Colorado claims productive. I heard the other day that a large number of American farmers were leaving America and going to Canada. I asked why it was, and I was told they were leaving America because their lands were becoming exhausted, and they were going to the virgin soil of Canada, where they could grow the good crops they used to get in America. Now, if the lands under irrigation in Colorado are to be productive, you must do the best you can to transfer the silt from the river on to the lands. Major Beacom said he was not aware what the volume of silt was that passed down the Nile. I happen to know the figures. Sir William Wilcox gives the proportion of silt in the river, and I find that about the same quantity of silt passes down the Nile in a big flood as comes down the Colorado; that is, the maximum of any day of the year is about the same, but the Colorado carries rather more than the Nile.

The total quantity of silt which passes down the Nile during a whole year is given by Sir William Wilcox in his book as 47,000,000 cubic yards. I dare say these figures convey to you very little impression of the volume. You know Hyde Park and Kensington Gardens. The houses all round them are about 50 feet high. Now, suppose you filled the whole of Hyde Park and Kensington Gardens up to the top of the present houses with mud from the Nile, and then, on the top of the present houses you built another lot of houses 50 feet high, and still a third lot of houses 50 feet high on the top of the second lot, and then filled up the whole area to the top of the third set of houses, the quantity you would absorb would be about the volume of mud which comes down the Nile in a year. A large portion of this silt is spread over the land in Egypt, and it is to that that the land owes its fertility. I feel a little doubt whether, if these irrigated lands in Colorado have to depend largely upon reservoirs, they will retain their fertility; for, mark you, when you put water into a reservoir and keep it there a long time, all the fertilizing matter which ought to go on to the land, or a very large proportion of it, sinks to the bottom of the reservoir; you do not get it on your fields, and you choke your reservoirs with it. I think the American Engineers will have to consider whether some measures are not necessary to enable them to pass the silt which the Colorado river carries on to the lands, so that they may keep them up to their present standard of fertility. There are other points to which I should like to refer, but I feel I should not detain you longer. I will, therefore, only thank you for your kind attention.

Colonel CHURCH: In answer to the gentleman who has just spoken, may I say a word with reference to the silt question. The engineers of Canada tell me that there are 70,000,000 of acres of arid and semi-arid lands which can be irrigated there. If it is necessary to have silt to fertilize, for instance, a wheat-field, why is it that the further you go north the more bushels of wheat you get to the acre of land which is not irrigated? The reason is, that up to the limit of the wheat belt, the ground freezes to a depth of at least 5 or 6 feet. When the wheat begins to spring above the ground it is in the warm weather, when evaporation is constantly taking place, in a very gentle way, from that great ice-cap that underlies the soil. There is no silt in it. It is about the purest water you can get, and yet it will give you twenty-two bushels of wheat to the acre, while if you go south, to the border of

the United States, you get from eleven to thirteen bushels. Therefore, although the silt may be very useful, clear water may also be desirable. I may say that the largest and most beautifully irrigated field I ever saw in my life was in Northern Mexico, which was irrigated by a perfectly clear-water stream. It was growing Indian corn 10 and 11 feet high, with ears of maize nearly as big as my forearm. Is the silt question the main one in irrigation?

I may say something about my favourite Spanish-American country. If you follow that great arid region of the western United States (with its sixteen states) further south, on to the Mexican plateau, varying in elevation from 3000 to 4000 feet in the north to 7500 feet at the city of Mexico, you get a vast area which can be made into a garden wherever you can find water to put upon it, and the chances are that, in nine cases out of ten, if you get any river at all, it will be a clear-water one; and, as a general rule, wherever you see irrigation there, as I have seen it extensively, you will find it is from clear water. If you go still further south, to the tableland of the Andes, and their western slope, I can point there to the remains of irrigation works so extensive that it amuses me to hear about modern irrigation, and of the 5,500,000 acres of Egypt and the 9,000,000 of acres which, perhaps, were irrigated in the palmy days of the Chaldean empire! The ancient Peruvians also irrigated by the millions of acres, and you will find in Peru and Bolivia works absolutely tunneling the shoulders of the mountains. There are on the western slopes of the Andes sixty torrential clear-water streams which can be impounded and utilized as they were in the time of the Incas, and 50,000,000 of acres of land awaiting irrigation. The Peruvian engineers estimate that, even in a moderate way, they might irrigate 3½ millions of acres in Peru alone. When it rains there, as it does once in a long period of years, it is perfectly wonderful to see one of the coast deserts. In the course of a day or two it becomes a vast garden of flowers, great numbers of which are of unknown species, a vegetation which is absolutely marvellous in its appearance, a smile from Pleistocene times. And the next day you look, and it is gone; the arid region has reclaimed it again, and the rains, which have not carried a particle of silt, have disappeared.

The PRESIDENT: Unless any one else wishes to take part in the discussion, I am sure you will join with me in a very hearty vote of thanks to Major Beacom for coming here and giving us such an interesting address, and helping us to pass a very instructive evening.

Major BEACOM, in responding, said: I wish to assure my audience, in the beginning, that I shall not attempt to answer the many questions that have been asked, as that would take too much of your time, but I shall try and answer a few of them.

As to the amount of water in the arid states available for irrigation purposes, I would say that it is not sufficient for more than a small part of the vast region that would be benefited by irrigation; but it is proposed to make the most of existing supplies by increased economy in the use of water, and also to increase the supply, or at least to secure a steadier stream-flow, by preserving the forests on the headwaters of irrigation streams. The Government forest reserves now cover an area about equal to that of the British Isles.

Some exception has been taken to my comparison between the Nile and the Colorado, but I still think that the conditions, from an irrigation point of view, in the lower Colorado and the lower Nile are very much alike. The analysis of the soils shows them to be almost identical, and in the matter of rainfall and temperature there is very little difference. The proof of this similarity of conditions is found in the fact that most things that grow in Egypt can be grown as well in the lower Colorado.

I am not prepared to answer the question, "How are you going to train your

people to wait patiently for much-needed water until their neighbours' crops have been watered, as is often necessary?" We know that there are many difficulties in the way, and we have already sent experts over the world to study the systems of management found workable in other countries. We have concluded that there is nothing to be learned from India or Egypt, because the social and economic conditions in those countries are totally different from our own, but we hope to profit from the experience of the communities of Northern Italy, where the conditions are more like those in America. We are just making a beginning.

I would say, in conclusion, as it may be of interest to you to know, that President Roosevelt did much to secure the passage of the Reclamation Act—so much, indeed, that he may properly be considered the author of that important law.

A NEW ISLAND IN THE BAY OF BENGAL.*

By Lieut. E. J. HEADLAM, R.I.M. Survey of India.

HOPING that it may be of interest, I beg herewith to send a sketch, with a couple of plans and some photographs, together with this short account of a new island which was thrown up by the action of a mud volcano, in the Bay of Bengal, off the north-west corner of Cheduba island, on the Arakau coast of Burma, December 15, 1906.

The island is situated in lat. 19° 0′ 6″ N., long. 93° 24′ 20″ E., and is $8\frac{3}{4}$ miles in a north-west by north direction from the north-westernmost point of Cheduba island. It is in extent 307 yards long in its greatest length running south-south-west and north-north-east, and is 217 yards at its greatest breadth running in a north-west and south-easterly direction; the highest point is 19 feet above high-water mark, and it is entirely composed of mud, with a small quantity of stones of various sorts, but no lava.

On December 15, 1906, the workmen employed by the Public Works Department of Burma in constructing a lighthouse on Beacon island (which lies south-east by south about $4\frac{1}{2}$ miles from the new island) heard loud rumblings and rushing noises, and noticed that the sea was in a much disturbed condition to the north-westward; finally they saw a mass of land appear above the water. This, according to their account, twice disappeared and reappeared again; but this was probably only an optical illusion owing to the wave which was caused by the great displacement of water, which rose several feet above the normal, and probably washed almost over the island.

On December 20, on receiving the information from Mr. Dawson of the P.W.D., who had been on Beacon island, Colonel Huddleston, R.I.M. port officer of Akyab, visited the island, and found it still very soft and hot, but not in any way active. On December 30 the R.I.M.S. *Investigator*, under the command of Commander W. G. Beauchamp, R.I.M.

* Research Department, February, 1907. The discussion on this paper will be published with that on Mr. Sivewright's paper on the "Cutch and the Ran," which was read at the same time.

surveyor in charge of the Marine Survey of India (which was at the time in Akyab), received orders from the Government of India to proceed to the island for the purposes of scientific inquiry, and to fix its position and ascertain whether any further disturbance had occurred in the nature of the bottom of the sea in the vicinity. The *Investigator* arrived off the island on the morning of December 31, and anchored in 11 fathoms just over half a mile from the beach, having encountered no shoal water. Under orders from Commander Beauchamp, I landed, taking with me Captain R. E. Lloyd, Indian Medical Service, surgeon-naturalist to the Government of India in the Marine Survey of India, and two officers of the Marine Survey.

The island, on approaching from the eastward, presented a long low appearance of a uniform greyish-brown colour, having a small knob or summit on its southern end; no smoke or sign of activity was noticed; from a distance of half a mile the water shoaled gradually to the beach. On landing, we found the upper crust quite hard and cool, except quite close to the beach, where the mud was soft—so soft in places that we sank above our knees. The whole island was, with the exception of a small

FIG. 1.—GENERAL APPEARANCE OF THE ISLAND ON APPROACHING FROM THE EASTWARD AT A DISTANCE OF ABOUT HALF A MILE.

quantity of stones and sand, entirely composed of greyish-brown mud of a clayey nature, with an extraordinarily rough surface, caused by the quickness with which the boiling mud had cooled with exposure and the cessation of the eruption. The island is a rough diamond in shape, as shown in Fig. 2, with the highest part at the southern end, and extending in a ridge formation in a north-north-easterly direction, with small gullies and ridges branching off at either side. The main ridge is about 16 feet above high water (with the exception of the knob at the southern end), and is about 40 yards broad; the land then slopes down to the sea, being slightly steeper on the western side.

There was no activity visible except at the northern end, where several small craters, varying in size from 1 to 6 feet in diameter, were exuding liquid mud, but only in small quantities and not with any great violence. I computed that the whole output during the day I spent there would not exceed 2 tons. Except in the active area, the whole surface of the island was cool, the temperature of the mud in the shade being 86° Fahr., or normal for these latitudes at this time of year; below the surface I found that the greatest heat was at the extreme summit, which I imagine to have been the main crater, though now filled up. The result of several observations gave a mean temperature on the major portion of the island of, at 2 feet below the

surface, 96° Fahr., and at 3 feet below, 104° Fahr.: whereas at the summit the temperature 1 foot below the surface was 104° Fahr.; 2 feet

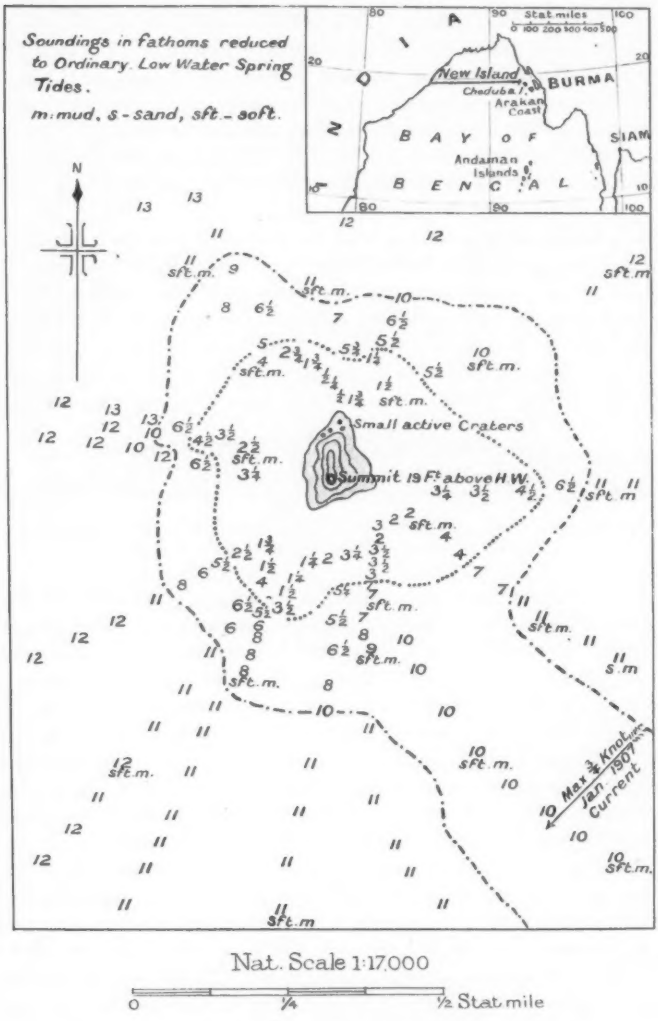


FIG. 2.—NEW ISLAND, BAY OF BENGAL.

below, 108° Fahr.; 3 feet below, 138° Fahr.; and 3 feet 6 inches below, 148°. The whole island gave out a strong smell of sulphur, which was almost overpowering close to the holes bored for taking the temperatures.

A good deal of driftwood had been washed up during the fortnight that the island had been in existence, and Captain Lloyd discovered fifteen varieties of seeds and pods which had already found their way there, blown, or washed up, or deposited by birds that had already commenced to utilize the island as a resting-place. The discovery of such a number of seeds gives a good idea of what a very short time it would take for vegetation to grow on an island of this description situated not many miles from the mainland. At the summit of the island a few bones and remnants of fish were found, evidently left by birds. A large fish-eagle was hovering over the island during part of the time we were on shore, evidently only waiting for us to take our departure before he landed to deposit the large fish he was carrying. Amongst the stones found were small portions of granite and sandstone.

During the time I was on the island two steam cutters were employed, under surveying officers, sounding round the island, to ascertain how far the shoal water extended, and whether any other shoals had formed, but nothing outside the island itself was found. Discoloured water off the island we had noticed from the *Investigator*, which looked like shoal water, was due entirely to the washing away of mud from the island, caused by the sea breaking round its edges. The island rises gradually from a depth of 11 fathoms, the diameter at the base being a little over half a mile, beyond which the depth was found to be as shown in the Admiralty chart, No. 832, of "Cheduka Straits," surveyed in 1884. On Fig. 2 will be found the soundings obtained immediately round the island reduced to low water springs; and in Fig. 3 the island is shown in section north and south, indicating the gradual rise from the bottom of the sea.

At this early date it is hard to say whether the island is likely to remain as a permanency, being composed almost entirely of mud, only 20 feet above high water at its summit, and fully exposed to the force of the south-west monsoon. I should imagine it might wash away and remain

FIG. 3.—THE VOLCANO IN SECTION, NORTH AND SOUTH.

only as a shoal, unless in the intervening five months of fine weather enough driftwood and sand with small stones have formed a secure beach, and grass and young shrubs helped, with the hardening clay of the interior, to bind the whole sufficiently together to withstand the force of the sea and rain in the monsoon.

A study of this portion of the Burma coast seems to show that this island is part of a chain of mud volcanoes which appear along the eastern side of Cheduka island and the islands immediately to the southward, some of which are several hundred feet in height and are occasionally active; and again continuing the line for some 50 miles further to the

FIG. 4.—WATCHING THE LIQUID MUD EXUDING FROM SMALL CRATER. DISTINCT RUMBLINGS WERE HEARD.

northward, we came to another mud volcano (active, but still some feet below the surface of the sea), which is situated just inside the southern point of the Eastern Borongo, about 20 miles south of Akyal, and which was discovered by the officers of the R.I.M.S. *Investigator* whilst surveying there four years ago.

The photographs give a very good idea of the extraordinary roughness of the ground, and of the liquid mud as it poured down from the small active craters. The beacon and flag on the summit were erected as a mark to help in fixing the position, and also to draw the attention of passing ships to this uncharted danger, which, on account of its lowness and drab colour, is very difficult to see until fairly close, more especially in misty weather. The photographs were very kindly

FIG. 5.—WATCHING THE ACTION OF AN ACTIVE CRATER. THE BROAD STREAM OF LIQUID MUD IS EASILY NOTICEABLE FLOWING AWAY FROM THE CRATER.

FIG. 6.—GENERAL VIEW OF SOUTHERN END OF ISLAND, WITH SUMMIT (OR MAIN CRATER), AND BEACON FLAG ERECTED TO WARN VESSELS.

presented to me by Assistant-Engineer Hindman, R.I.M., who landed with me and took them.

SOME NOTES ON THE SAN FRANCISCO EARTHQUAKE.

By JACQUES W. REDWAY.

THROUGH the researches of the State (California) Earthquake Commission, much interesting knowledge concerning the immediate cause of the earthshock in the vicinity of San Francisco has been brought to light. The geological and tectonic investigation was assigned to Prof. George Davidson, F.R.G.S., well known as an authority in both geology and geodesy. Prof. Davidson adopted the practical plan of sending out some very bright and enthusiastic young men with cameras and surveyor's tapes, and probably no earthquake has ever occurred the facts and effects of which have been more carefully observed. I have had the pleasure of studying the records obtained by two observers—Mr. R. S. Holway, of the University of California, and Mr. C. T. Wright, of the Redlands High School, each in the department of Geography. I also was enabled to compare my own experiences at the time of the great shock of 1868 with the experiences of those who suffered the shock of April 18, 1906.

The city of San Francisco is situated on a peninsula that is essentially a much-fractured block of the coast ranges. The ridge in question is probably post-Jurassic—possibly early Cretaceous. Cherts, sandstones, and schists, with here and there intercalated lava-flows, compose the rocks of the block. The strata are much disturbed; in various places the angle of tilting is 50°, 60°, and 70° or more.

The faulting of the block is also extensive. A profile on a line extending north-east and south-west through the middle of the peninsula would show, at the least, half a dozen faults. Three of them, charted on the accompanying map, are bold and extensive, and an ideal (not actual) profile is illustrated in Fig. 1. The aggregate amount of displacement is estimated at several thousand feet. The interference with the former drainage slopes is evident from the fact that numerous small lakes have been formed along the lines of faulting.

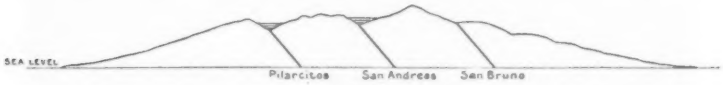
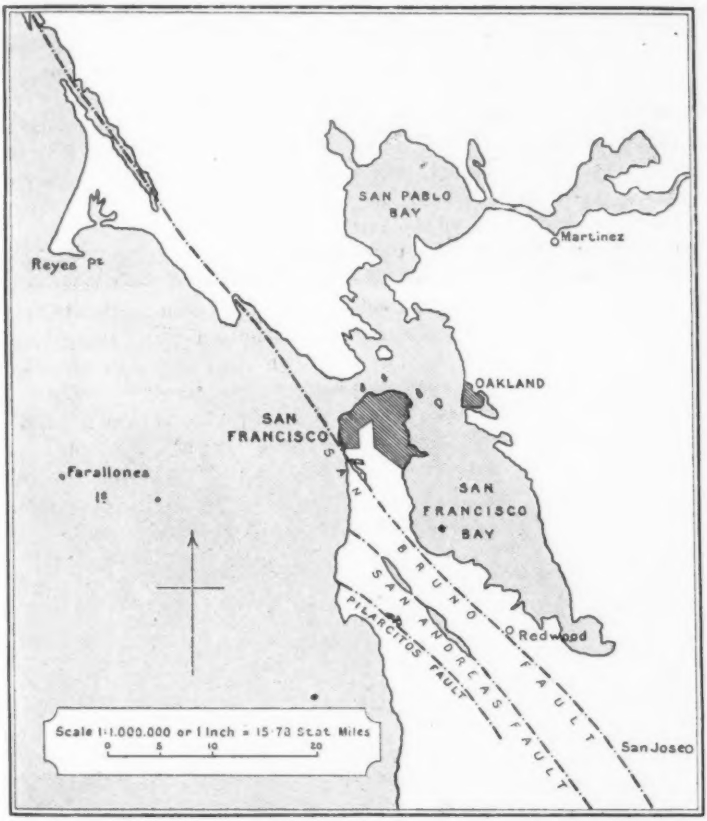


FIG. 1.—AN IDEAL PROFILE ACROSS SAN FRANCISCO PENINSULA, SHOWING THE PRINCIPAL FAULTS AND THE INTERRUPTED DRAINAGE.

The earthquake of 1906 was thought at first to be due to a movement along the line of the San Bruno fault, but closer investigations have proved that the disturbance was chiefly along the San Andreas fault (see map). Possibly both faults were involved. The rift made by the earth-movement is traceable along or near the dotted line of the fault (see map), a distance of about 50 miles. In loose soil it appears usually as the hillside of a furrow; in hard earth as cracks, crevices.



SAN FRANCISCO AND NEIGHBOURHOOD, SHOWING PRINCIPAL FAULTS.

Mr. Holway describes the appearance of the disturbed rock-waste in Fig. 2 as "plowed land."

So far as I was able to learn, the vertical displacement did not exceed 3 or 4 feet in any locality; throughout the greater extent of the rift it was not more than a few inches with regard to the

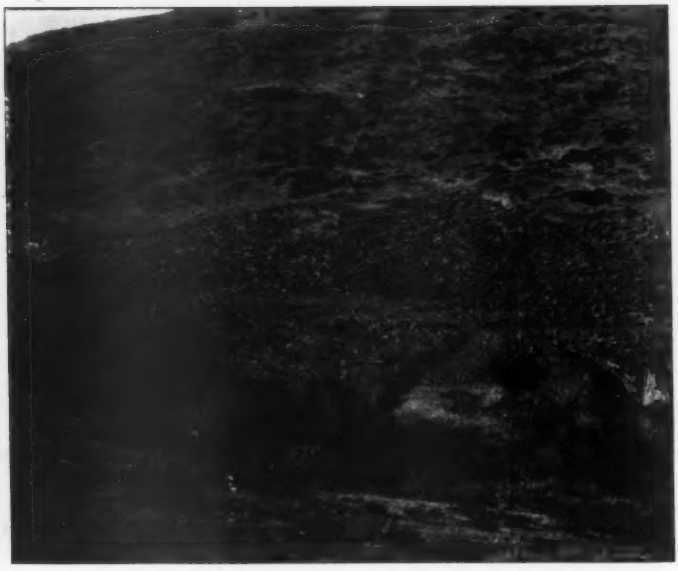


FIG. 2.— PLOWED LAND ALONG THE EARTHQUAKE RIFT.
(*R. S. Holway, photo.*)

FIG. 3.—LATERAL SHIFT OF FAULT.
(*R. S. Holway, photo.*)

FIG. 4.—LATERAL SHIFT OF FAULT.
(*C. T. Wright, photo.*)

FIG 5.—A TWIST AND DISPLACEMENT OF A COUNTRY ROAD.
(*C. T Wright, photo.*)

relative position of the two sides of the rift. This is shown in all of the photographs; the relative level is preserved.

The lateral shift is shown actually in the photographs Figs. 3, 4, and 5. In Fig. 3 there is no vertical displacement, as at first appears; on the contrary, there was merely a shearing of the bank of earth, one side being driven forward. The man at the right hand stands at a point in the former line of the fence; on the left, Mr. Holway's position marks the line to which the broken end of the fence was shifted—a distance of 15 feet 6 inches. The short section of fence against which he is leaning was built after the shock, in order to close the gap. A similar displacement is shown in Fig. 4. This photograph was taken by Mr. Wright, and the locality is about 30 miles from that of Fig. 3; the amount of displacement may be judged from the photograph. Fig. 5 is from a photograph taken near St. Reyes, and is a most interesting exhibit. The road was formerly straight; the "plowing" is here very evident, and it covers a width marked by the distance between the men in the middle and the background. The lateral displacement is about 16 feet. Before the shock the road was straight; the two ends of the fracture now are not even in alignment.

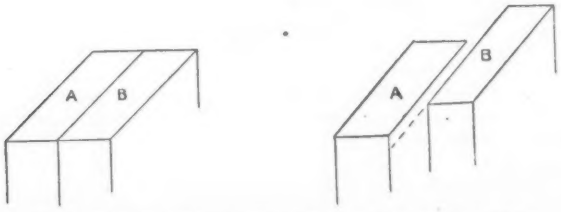


FIG. 6.—DIAGRAM ILLUSTRATING THE LATERAL DISPLACEMENT OF BLOCKS.

The question concerning the visibility of the earth-wave itself seems to be as uncertain now as it was in the case of the shock of 1868. The following phenomena have been observed, however, beyond doubt:—

Columns of dust shot upwards at the instant of the passage of the earthwave.

The violent vibration of trees and buildings caused by the passage of the wave.

From an economic standpoint, there is no question concerning the superior stability of steel buildings; but few of them were materially damaged by the shock.

The damage resulting from the earthquake was not great; 95 per cent. resulted from the fire. The chief mains crossed the fault, and the shearing of them rendered the control of the conflagration an impossibility.

SURYEYS IN INDIA AND IN EGYPT.

The Indian Survey Report for the year 1904–1905 commences with an interesting summary of the recommendations of the late Special Survey Committee (a subject to which reference has already been made in the *Journal*), and *inter alia* repeats in more official form the substance of Colonel Longe's letter in the recent February issue. The recommendation in favour of a uniform one-inch topographical map of the whole of India, which is essentially military in its inception, is apparently framed on a curiously low estimate of the value of the topographical mapping on various scales already published, which leaves little of the Indian peninsular area untouched; and on a high estimate (almost equally remarkable) of the value for military purposes of uniformly accurate one-inch mapping over vast areas where no military movement ever has, or ever will, take place. The "whole of India" is a very large area to deal with, and we agree with the statement of the Surveyor-General that, with more than half a million of square miles of original survey, and nearly half a million of resurvey, to be made within twenty-five years, the present staff of the department is quite inadequate. The decrees of the Indian Government, however (especially as regards the Survey department), are not as the laws of the Medes and Persians, for they change with almost periodic certainty; and when the resurvey of, say, the deserts of Rajputana or the jungles of the Godavari basin are once again to be subjected to the process of accurate and systematic plane-tabling on the one-inch scale, based on close triangulation, there will doubtless be a reconsideration of the recommendations of the committee.

This is presumably the last Indian Survey report which will include the operations of the Cadastral and Forest branches, which absorb about half the working strength of the department. In future the survey is to deal almost entirely with topographical and scientific issues, and it is a matter of congratulation that the scientific branch has been left practically uncrippled by reform to carry out those important investigations which have been conducted lately with so much success under Colonel Burrard. There is, indeed, only one trigonometrical party in the field working on geodetic lines, and to that one is entrusted the unenviable task of carrying triangulation westward through Baluchistan; but the tidal and levelling, the magnetic, the pendulum, and the astronomical parties have all of them many important observations yet to make before they can bring their operations to a close without losing the necessary continuity in the general scheme of action.

The topographical and geographical outturn for the year under review amounts to a very considerable figure. In Tibet, Seistan, and Somaliland nearly 100,000 square miles of geographical survey were covered, besides 4000 on the Burmo-Chinese frontier; and the total outturn of accurate detail work was no less than 132,738 square miles. This includes mapping in the Shan States, Burma, Bengal, United Provinces, Punjab, Sind, Baluchistan and the North-West Frontier Province, showing how widely the topographical parties of the Indian Survey are scattered over India.

The story of the reproduction and publication offices in Calcutta is but a continuation of an historical series which recounts the impossibility of dealing with the mass of work thrown on it, departmental and extra-departmental, without an adequate staff to meet it. 95,387 sheets were issued during the year, whilst eleven general maps of India, on scales ranging from 32 to 256 miles per inch, were in hand, as well as seventeen sheets of the map of India and adjacent countries on the 1 : 1,000,000 scale, fourteen of which were published. Sympathetic reference is made to the loss occasioned to the department by the retirement of Colonels Wahab and Hobday.

The "Narratives"* from which extracts have been taken for publication in the Report before us are those of officers of the Indian Survey Department who are employed on work of scientific investigation. There is little of topographical, and nothing of geographical, interest in them if we except certain results derived from Captain Wood's mission to Nepal. They afford, however, most convincing proof of the strenuous nature of the work of the scientific branch of the department, and should serve amply to justify the maintenance of a well-matured system of scientific investigation in the eyes of those critics who are disposed to assert that India cannot afford to be scientific.

No less than 128 pages out of the 187 which comprise the Report are devoted to the reproduction of tables giving the results of magnetic observations, which are further illustrated by a map showing the stations of observation of the magnetic survey. Since the year 1901 these have been carried practically over the whole peninsular area, with the exception of the Central Provinces. A description of some of the stations and of the instruments used completes the narrative, but no general deductions are made, nor is any indication afforded as to the practical result of these undoubtedly valuable observations.

Major Conyngham's report on the pendulum observations for determining the force of gravity is directly interesting. The latest instrumental equipment for this class of observation includes "half-second" pendulums, which are only quarter the length of those previously used in the department. A new method (an Austrian invention) has also been introduced for registration of the coincidence of beat between the free pendulum and the clock pendulum, the pendulums being no longer swung *in vacuo*. A considerable increase in accuracy of observation has thus been assured, further refinements being introduced in the corrections applied for the minute vibrations (or "wagging") of the stand on which the instrument is fixed, due to the swing of the pendulum. Some of the results are curious. For instance, it was found at Calcutta that the perpetual tremor or vibration, set up by traffic, due to the nature of those alluvial deposits on which the city may be said to be floating, absolutely negatived the value of the observations; whilst, on the other hand, observations taken at Colaba, in Bombay, were not affected appreciably by the firing of the big guns of the fort in their vicinity.

The value of g (force of gravity) being used to determine the figure of the spheroid and the density of the Earth's crust, it was found at Colaba that the excess of attraction indicated by the observations equalled that which would be accounted for by a disc of earth-matter below the instrument 2530 feet thick, with an excess of density equal to 2·8 above the average of surface density. At Dehra Dun, on the other hand, the defect in g indicated a deficiency in density of 2·8 extending to 2930 feet in depth. Assuming that the surface density is 2·8, this means that we must imagine a cavity 2930 feet deep under Dehra Dun. In other words, "the matter underlying Dehra Dun is so deficient in density—we do not know to what depth this deficiency may extend—that it would have to be pressed downwards until the surface of the land was 2930 feet below its present position before it would attain the average density of the crust of the Earth. Likewise at Colaba an expansion of the underlying strata until a hill 2500 feet high had been formed would be requisite to reduce the excessively dense rock that is found here to the average density of 2·8."

Certain levelling operations referred to in another part of the Report have been undertaken in the interests of these pendulum observations to determine the difference of level between Dehra Dun and Mussuri.

* Extracts from Narrative Reports of Officers of the Survey of India for the season 1903–4.

Valuable results still continue to be obtained from the tidal observations, which extend over forty-two ports from Aden to Port Blair. Tide-tables for forty ports are now published in England, based on the observations of the Indian Survey. Several instructive tables will be found in the Report, especially those showing the errors in the predicted times and heights of high and low water at the various stations. These tables apparently indicate a superiority in the automatic system of recording.

Amongst the most interesting records of the season are the results obtained by a careful recomputation of Captain Wood's observations for determining the position of Everest and the other high peaks in Nepal. The more rigorous methods employed give a very slight difference (never amounting to half a second of arc) between the new and old determinations of the co-ordinate values of the stations of observation, which differences are reflected in a greater degree in the values of the peaks observed; but the corrections in altitude of the peaks observed, due to the employment of a revised coefficient for refraction, are more marked. The height of Mount Everest, for instance, is reduced by about 300 feet (28,700 instead of 29,000 feet), and a general reduction in altitude of most of the peaks is apparent. This, however, must not be accepted as the final determination. There are other factors in the computation of altitudes observed under extraordinary conditions still to be determined with more rigorous exactness, and it is quite possible that the ultimate altitude of the highest mountain in the world may be fixed at a higher figure than 29,000 feet rather than a lower one.

A short statement of the progress of topographical surveys in Sind (with no narrative of interest) and of riverain surveys in the Punjab, with a few notes on town and municipal surveys generally, completes the Report.

Turning to the Egyptian record for the same year, we find an equally busy department with an even wider field of investigation. The Egyptian Survey department is the "universal provider" of scientific advice to Egypt. Not only does it concern itself primarily with base line measurements and the extension of geodetic triangulation of the highest class, but it includes the analysis of milk from "the Zoo," though what animal furnished the milk is not stated. It is, in short, just what such a department should be under strict financial management. Nothing is wasted in the administrative staff of geological, meteorological, seismologic, or other scientific offices. All are combined under the practical direction of that most capable officer, Captain Lyons, F.R.S.

The most interesting feature of the report from the geographical point of view is the extension of triangulation up the Nile valley to Wady Halfa. This means that a direct series has been measured through 1050 kilometres of meridian from Egypt as far south as the parallel of 22° N. lat. This triangulation is not geodetic, and consequently, as a series of the second order, cannot take its place directly as part of the great arc series which will eventually extend from Natal to Cairo. But it will assist greatly in facilitating the operations of final measurements of that arc, and it is a most important contribution towards it. The reassessment of the land has created a great demand for triangulation in the delta, which, being a highly developed area, requires the greatest possible accuracy in measurement for cadastral purposes. Very much has been done already towards the attainment of this desideratum. Preliminary work for the commencement of the strictly geodetic triangulation of Egypt has been entered upon, and the hope is expressed that this will eventually be connected with the same class of work in South Africa, and be extended from the North Cape to Greece. "When completed and connected, the combined work will be extended from lat. 34° S. to lat. 70° N., and should greatly add to our information with regard to the form and dimensions of the Earth, a most important and interesting

problem." This is undoubtedly true, but it would perhaps assist more towards the financing of the project if the practical importance of at least one central geodetic chain were insisted on for the purpose of securing as a basis and backbone to all subsequent map-making in Eastern Africa. The determination of the Earth's figure is not the only, nor the most important, aim of this costly and lengthy class of triangulation. The enormous practical value of such a gigantic arc measurement is often apparently overlooked by its scientific advocates.

In this connection there is much interesting information on the subject of base measurements, and the care and labour which has been bestowed on securing the best possible instruments. The Jäderin method of measurement has not proved uniformly successful owing to the want of standardization, and the uncertain tension of the wires, but with the introduction of proper standards for comparison the extra rapidity which can be introduced into the process of base measurement by the use of this apparatus fully ensures its constant application in future. Ten bases were measured, either with the Jäderin or with a 100-metre steel tape, in the Nile series. An 8-inch micrometer theodolite was employed in this series, and the probable error in the observed angles is reckoned at 1·44 seconds.

Topography, lately, has been chiefly confined to compilation from large-scale mapping of the delta area.

In the meteorological and magnetic branches an immense amount of useful work has been done, as also in the geological section; and the river-gauging has resulted in valuable data regarding the Nile water-supply. It has been found, for instance, that the volume of water at Khartum (when the Atbara is not contributing) is greater than it is at Aswan (Assouan). How much of the diminished volume at Aswan is to be attributed to "seepage" (as suggested) is possibly open to question.

On the whole the report is one of which Captain Lyons may well be proud, for it is a great record of a most useful department thoroughly well organized and administered.

T. H. H.

REVIEWS.

EUROPE.

Unconventional Travel.

'A Cruise across Europe.' By Donald Maxwell. London: John Lane. 1907. Size 9 × 5½, pp. 254. *Price* 10*s.* 6*d. net.*

This delightful book is the record of a fresh-water voyage across Europe from Holland to the Black sea, in a small barge. The route taken was by way of the Rhine, Main, Ludwig canal, and Danube. Undoubtedly the most interesting part of the journey was the passage of the Frankischer Jura mountains by Charles the Great's Ludwig canal, with its hundred locks, the tolls for which worked out at the enormous sum of six marks for the lot. In this part of their trip the voyagers were literally sailing among the mountain-tops, and the experience was as interesting as it was unusual. The travellers met with numerous adventures, being at one time arrested as spies, and at another mistaken, by the unsophisticated peasants, for pilgrims to the Holy Land; but in spite of everything they safely reached their destination. The book is well written, and the author's really beautiful illustrations greatly add to its interest and attractiveness.

ASIA.

Syrian Sketches.

'The Desert and the Sown.' By Gertrude Lowthian Bell. London: Wm. Heinemann. 1907. *Price* 16*s. net.*

This volume appeals primarily to the human and the antiquarian instincts. Most travellers have suffered at times from their inability to converse easily with the inhabitants of the region they were traversing. Miss Gertrude Bell has the rare qualification of being fluent both in Persian and Arabic. Besides a keen enjoyment of travel, she has a very thorough sympathy with oriental modes of life, thought, and speech. She has, further, a talent for reproducing with convincing and dramatic effect her conversations with her hosts or companions of the road. Consequently, the reader, before he finishes her volume, will know more about Syrian character, the life of the desert and the mountain, than he might gather from half a dozen ordinary travellers' diaries. There may not be much new geography, in the strict sense of the word, in her pages, but they contain most graphic landscapes—pictures of a Syrian spring, its frosts and flowers, of the wide cornlands of the Hauran, the lava labyrinths that have flowed from the dead volcanoes of the Jebel Druz, and the bleak uplands of the valley of the upper Orontes. Miss Bell's Syrian travels extended from Jerusalem to Alexandretta, and led her through many wild districts and to not a few unvisited or little-known sites.

Crossing the Jordan, she journeyed first round the eastern slopes of the Jebel Hauran. In this region, on the edge of the desert, the ancient feud between Druse and Arab runs its perpetual course. Flocks and herds, as in the days of Job, are swept off by Arab marauders; the mountain villagers plan a foray of revenge. The author gives a most picturesque description of how at Salkhad, the old fortress that looks out east over the unbroken plain and the paved Roman highway to the Euphrates, she found herself joining in a moonlight dance of Druzes preliminary to one of these forays.

From Damascus, where Miss Bell saw much of Eastern life, she went north past Baalbek to Homs, Aleppo, and Antioch, visiting on the way many of the wonderful ruins of Roman cities, Christian fifth and sixth century churches, and crusaders' castles, that are scattered over northern Syria, silent witnesses to the extent of ancient civilization and of Mohammedan destruction. Her pages may inform the general reader, to whom the works of De Vogüé and later explorers, German and American, are unknown, of the existence of a classical church architecture, dating from at least A.D. 372, based on the use of the arch, and anticipating in many of its features the Western Romanesque. It was largely employed for domestic as well as for ecclesiastical uses. Combining Roman strength in construction with oriental delicacy in detail, and showing great power of adaptation, it has a dignity and charm which photographs fail adequately to convey. Its full development was cut short by the Arab invasion while it was still a living art, and its relics, scattered over desert lands, impress the traveller with a sense of the impermanence of empires and even of civilization itself.

Miss Bell has added to the catalogue of ancient sites and copied fresh inscriptions. But it is as a living picture of the present state of Syria and a fascinating glimpse into the mind of the East that her book will be most widely read and valued.

The illustrations are numerous and good. In a few instances, however, they seem to have been chosen on the principle "when you have not what you want, use what you have;" and there is consequently a divergence between them and the letterpress. Thus the beautiful temples of Kunawat on the western slope of the

Jebel Druz, visited by Miss Bell in a previous journey, but not described here, are largely depicted. A map which combines much recent topographical work adds value to the volume, which has also a good index. Need its paper have been so heavy and glossy? D. W. F.

Early Cartography of the East.

'Studi Italiani di Filologia Indo-Iranica diretti da Francesco L. Pullé.' Anno 5, vol. 5. La Cartografia antica dell' India. Parte II. Il Medio-evo Europeo e il Primo Rinascimento. Firenze: 1905. *Atlas, separate. Price* 20*s*.

Another instalment of this useful work is cordially to be welcomed. The geographical knowledge of the Middle Ages, especially in relation to India, is here treated in considerable detail, mainly from the cartographical point of view; and illustrations (of somewhat unequal degrees of merit) are given of portions of many of the chief mediæval maps, from the eighth century onwards. The clarified reproductions of the Orient from the *De Statu Saracenorum* of William of Tripoli, from the *Laurentian Portolano* or *Atlante Mediceo*, from the Turin and British Museum *Beatus* maps, from the Paris manuscript of Lambert of St. Omer, and from Henry of Mainz ("Enrico da Magonza"), are deserving of special notice; so is the representation of Dante's conception of the same regions, and the whole treatment of the Catalan Atlas of 1375, especially in comparison with the Catalan maps of Florence and Modena. On the other hand, the treatment of the Albi, Cotton, St. Sever, and Hereford maps, of Guido's design of 1119, and of the Wolfenbüttel manuscript of Lambert of St. Omer (see pp. 8, 11, 18, 22, 39, and *Tavola D*) is not equally successful. Will Count Pullé allow me to beg him, in a second edition, to give references to the manuscript authorities, especially the manuscript designs, here chiefly utilized? Thus on p. 14, 'Il Paradiso al posto dell' India nel cod. del Museo Britannico,' needs supplementing by the proper reference—*Additional MSS., 11,695, fols. 39 v.–40 r.* Again, may I draw his attention to the erroneous spelling, as in Konrad Miller, of *Beaven* for *Bevan*, the vicar of Hay, whose study, conjointly with Phillot, on the Hereford map, has been of service to so many students (see p. 38)? The author will doubtless wish to harmonize the forms *Oderico* and *Odorico* on pp. 52, 53, as they both refer to one and the same Friar Odoric of Pordenone. *Rubrouck*, rather than *Ruysbroek* (p. 47) is surely the proper local form of Rubruquis' name—as the great traveller's origin is pretty certainly not Brabantine, but from the modern French Department of the Nord, and from *Rubrouck*, in the neighbourhood of Hazebrouck.

I cannot follow the author in his *double* Genoese expedition, in connection with the Vivaldi family, of *1281 and 1291* (p. 65), depending as it does upon the full acceptance and stern pressing of every detail in the late and rather doubtful fifteenth-century authority Antoniotto Uso di Mare, who may easily be reconciled with the primary and contemporary witnesses by the admission of some slight inaccuracies. Citations of English should be carefully revised, to avoid passages such as "*Thirt* edition . . . with a *memory* of H. Yule" (p. 112). And would it not be better to quote Luke Wadding's *Annales Minorum* by its proper Latin title, rather than as if it were an Italian work (*Annali dei Minoriti*, p. 93); not to convert the *Fontes Rerum Bohemicarum* into *Fontes Rerum Bohemorum* (p. 94); and to give, for the Catalan Atlas of 1375, its proper numbering in the Bibliothèque Nationale—*Armoire X., No. 11, Espagnol 30*—rather than its place in Morel Fatio's Catalogue (p. 110)? Lastly, I may remark that the oldest mediæval map is not that in the St. Gall Isidore of about 680–700 (p. 5), but is the mosaic design of about 550, portraying parts of Palestine and Egypt with such surprising accuracy, rediscovered in 1896 at Madaba, in Moab.

C. R. B.

AFRICA.

Algeria.

'Algiers and Beyond.' By M. W. Hilton-Simpson, F.R.G.S. 32 *Illustrations*. London: Hutchinson & Co. 1906.

This book consists of notes of travel in various parts of eastern Algeria during 1903 and 1905, and is written with the object of inducing more English people to visit comparatively little-known regions of that country. It contains a good deal of useful information, though it is in no sense a substitute for Sir Lambert Playfair's extremely valuable guide, published as one of Murray's handbooks. Mr. Hilton-Simpson writes sensibly on natural history and on the differences between the Berber and Arab inhabitants. Of the Arab husbandman he remarks aptly that prayer seems to be the principal means by which he cultivates his land. It is unfortunate that the French method of spelling native names has been adopted, and that much space is given up to trivialities; nor need the author have made such an open display of his ignorance of and lack of interest in the history and antiquities of Algeria. The illustrations, all from original photographs, are excellent and well chosen.

North Africa after Herodotus.

'Nordafrika (mit Ausschluss des Nilgebietes) nach Herodot.' Von Richard Neumann. Leipzig: Gustav Uhl (*n.d.*). *Price* 2*m*.

This is a book of value, which will interest alike the geographer, the naturalist, and the anthropologist. Commencing with a study of the climate, fertility, and habitability of North Africa (chap. i.), the author proceeds to deal with the topography and inhabitants of the North African coast (chaps. ii., v.), with the north-west littoral (chap. iii.), with the story of the journey of the young Nasamonians, with the oases more or less clearly noticed by Herodotus, and with the fauna and flora of the coastal, mountainous, and desert zones of North Africa. Herr Neumann is to be congratulated on the care and thoroughness of his Herodotean inquiries, on the manner in which he conducts his researches and presents his results, and, above all, on the valuable matter which he has to offer us—notably, as to ancient marriage customs, styles of armament, methods of fighting, and religious ideas and observances, among the natives of those parts of North Africa which fall within Herodotus' view. The treatment of the Ammon and Aujila oases, of that of the Garamantes, and of the Atlas mountain system, also deserves especial recognition. All students will be grateful to Herr Neumann for his elucidation of Herodotean Africa.

Physical Geography of Morocco.

'Dans le Bled es Siba. Explorations au Maroc. Mission de Segonzac.' Par Louis Gentil. Masson et C^ie^. Paris: 1906.

The journeys made by Mr. Gentil in Southern Morocco throw some welcome light both on the structure and topography of the little-known Atlas region. He crossed the High Atlas at four different points—over the Bibwan pass, the Tizi n Test, the Tizi n Takhrat, and the Tizi n Imuras—thus traversing on the southern side the low plain of the Sus, to which the mountains drop in the west, and the plateau draining to the Wady Draa, which flanks them on the east. Mr. Gentil also explored the great *massif* of Sirwa, which divides these two hydrographic basins, while between these different expeditions he spent some time investigating the coastal region south of Mogador. Here the actual littoral consists of a line of sand-dunes 350 to 450 feet high, backed by a resistant Tertiary sandstone plateau with a steep escarpment

coastwards, on the edge of which Mogador is built. The dunes which result from the disintegration of the sandstone by wave-action are moving and spreading inland, except where they are fixed by a vegetation consisting chiefly of a cactus-like species of euphorbia. The plateau provides a somewhat scanty pasture, with only a few patches fit for cultivation owing both to the stony nature of the ground and the scarcity of water, and is thus thinly inhabited. The springs are few in this country, because, although clays of Cretaceous age underlie the sandstone, they are usually deeply buried, and the spring-level or junction of the two formations is seldom exposed. Only in the less dry parts and near the river-valleys is there any tree growth, but forming here a fairly dense forest. Farther inland, between this plateau and the Atlas, lies the region of wider plains and plateaus, formed of horizontally lying clays and limestones of Cretaceous origin, separated by flat-topped ridges, in which lies the city of Marakesh. It is a fertile, well-cultivated, and populous country, with its fields of grain, its olive orchards, its almond trees, and extensive system of irrigation works. The outliers of the Atlas system which bound the plains to the south and east, forming several ridges and valleys parallel to the main axis, are of Cretaceous sandstone capped with Jurassic limestone weathered into sharp peaks and needles, across which the rivers cut in beautifully wooded gorges. But just east of the meridian of Marakesh is a Carboniferous belt which reappears on the southern flank of the Atlas. The existence of this rock in the Eastern Moroccan Atlas was stated by Balansa in 1868. Subsequent investigations have hitherto failed to confirm his statement, but Mr. Gentil has been able to prove its correctness. In the high central region of the Atlas, red sandstone of Permian age and primary black schists play the chief part. These schists are generally unfossiliferous, but were supposed to belong to the Silurian series, and Mr. Gentil has determined this by the discovery of a great number of graptolites in the eastern region near the Tizi n Imuras. In the red sandstones of the eastern Atlas are important intrusions of volcanic rock on both sides of the central crest. On the southern flank of the mountains in the west the schistose rocks are very steeply inclined to the low plain of the Sus, and are cut by deep ravines sparsely wooded with evergreen oaks and junipers, whose torrents feed that river. Near the foot of the Atlas the plain is strewn with boulders, leaving only small patches fit for cultivation, which form the sites of tiny villages, but the central valley—the plain of Huara—is a wide, flat, alluvial tract, well cultivated, with its important agricultural and commercial centre, Tarudant. There is no snow on the southern slopes of the Atlas below 10,000 feet, while on the north side the snow-line lies at about 5000 feet.

East of the Jebel Sirwa the Atlas mountains are flanked by a rugged plateau of a much higher elevation, being only about 1600 feet below the level of the passes, an absolutely barren region with scarcely any habitation. It is formed mainly of Carboniferous rocks, of which limestone is the most widely distributed formation. The lower central portion of this plateau, however, Mr. Gentil found to be Cretaceous, a system not hitherto thought to occur south of the eastern Atlas. The Sirwa *massif* itself is a transverse volcanic chain connecting the high Atlas and the Anti-Atlas, and has only once been crossed before, by Rohlfs in 1862. It rises from a base of gneiss and other crystalline rocks (mica-schists, etc.), with a steep slope to the west and a gradual ascent on the east. The latter flank is composed of great lava-flows, through which the rivers have cut their channels down to the granitic rock with beds of trachyte and porphyry, the summits being formed of volcanic ash. In structure and configuration this region, with its domes and flat-topped heights, has a great resemblance to the volcanic country of Auvergne, and it stands on an ancient crystalline platform comparable in miniature to the central plateau of France. The small amount of vegetation, which consists chiefly of evergreen oaks, is confined to

the river-valleys. In his present volume Mr. Gentil gives simply the narrative account of his various journeys; a discussion of the scientific results is promised at a future date.

N. E. M.

NIGERIA.

'The Lower Niger and its Tribes.' By Major Arthur Glyn Leonard. London: Macmillan. 1906. Size 9 × 5½, pp. xxii., 559. *With Map.* *Price* 12*s.* 6*d.*

The title of this book is not altogether a happy one. The reader would have expected an account of the physical characters, sociology, and technology of the natives, whereas the book is a study of their religion and philosophy. The subject is a difficult one, and Major Leonard has not made it easier by wrapping up his ideas in a forced and ponderous style, which makes it difficult to grasp the author's meaning, as the reader gets lost in a maze of words and parenthetical sentences. In fact, had the style been simpler, the book might have been greatly reduced in bulk, and made far more valuable.

From the geographical standpoint, the most important section of the book is the first, in which is given a description of the physical features of the country and a classification of the different tribes. A good map shows the distribution of these peoples, of whom the most important are the Efik, Ibo, and Ibibio.

The rest of the book deals with the beliefs of the native, and will be of interest chiefly to the student of religions, although chapters on possession and human sacrifice may find a wider circle of readers. The scope of this part of the book may best be gathered by the headings of some of the sections—Religion, Spirit Land and Spiritualism, Emblemism, Demonology, etc. Climatic and geographical conditions have had a marked effect on these beliefs, and, as Dr. Haddon says in the preface which he has written, to the dramatic change between the wet and dry seasons "the author traces one of the manifold sources of the inherent dualism of native character and social life."

AMERICA.

THE CRUISE OF THE NEPTUNE.

'The Cruise of the Neptune.' Report on the Dominion Government Expedition to Hudson Bay and the Arctic Islands on board the D.G.S. *Neptune*, 1903-1904, by A. P. Low, B.SC., F.R.G.S., Officer in Charge. Ottawa: Government Printing Bureau. 1906. Pp. xvii.-355, 9 × 6 inches. *With Illustrations and a Map.*

A short account of the voyage and geographical results of the Canadian expedition in the *Neptune* to the Arctic islands has already appeared in the *Journal* (vol. 28 1906, p. 277). The present volume is the official report, and it deals at considerable length with the incidents of the voyage and the scientific results of the expedition. In addition to chapters dealing with geography and navigation, the latter of especial value, and appendices on the zoological and botanical specimens collected, there are reports on the Eskimo and on the geology of the region. Mr. Low's researches on the Central Eskimo, that is the tribes living on the north coast of Labrador, on Baffin Land, and on the shores of Hudson bay, add little to what was already known through the work of Dr. Franz Boas, but Mr. Low's report, being later, serves as a useful supplement to that of Dr. Boas. It is to be regretted, however, that Mr. Low did not adopt Dr. Boas' spelling and nomenclature, as by doing so apparent discrepancies might have been obviated, for it is not always clear whether Mr. Low's tribes are the same as Dr. Boas reported on under other names. Had Mr. Low, in his list of tribes, which is based on that of Dr. Boas, given the names, as recorded by the latter, in brackets, a certain amount of confusion would

have been avoided. Still, this does not greatly impair the value of his work, and it must be remembered that Mr. Low is, first of all, a geologist, and his geological chapters are most valuable. The book is admirably illustrated, and has this advantage over the usual run of Government reports—that it is very readable.

AUSTRALASIA AND PACIFIC ISLANDS.

Australian Tribes.

'The Native Races of the British Empire. Natives of Australia.' By Northcote W. Thomas, M.A. London: Constable. 1906. Size 9 × 5½, pp. xii., 256. *With 32 Plates and a Map. Price 6s. net.*

The idea of issuing a series of books dealing with the native races of the British Empire is an excellent one, and if the subsequent volumes are as good as this on the natives of Australia, the success of the series is assured. Such books are exactly what are wanted, as they will enable the general reader, who is interested in the peoples of the empire, to discover the facts about any particular tribe without having to consult a large number of highly technical works, while at the same time they should serve as an incentive to further study.

Mr. Thomas, who is an acknowledged expert on things Australian, has in this volume given a lucid and straightforward account of the various tribes living in the island continent. The book is devoid of technicalities, and, except in general chapters on Social Organization and Marriage, Mr. Thomas has actually steered clear of the subtle bypaths of Totemism, to the great advantage of his readers. The author devotes chapters to the manners and customs, occupations and pursuits of the natives, and in an introductory chapter collects together much useful information on the origin of the people and on the geography and physical features of the country. There is a good map, showing the distribution of the various tribes, while numerous illustrations serve to embellish what must be pronounced to be a valuable introduction to the study of the ethnology of the different tribes inhabiting Australia.

POLAR REGIONS.

The "Français" Antarctic Expedition.

'Journal de l'Expédition antarctique française 1903–1905.' Le *Français* au Pôle Sud. Par J. B. Charcot, chef de l'expédition. Préface par l'Amiral Fournier. Ouvrage contenant trois cents illustrations et une carte hors texte. Suivi d'un exposé de quelques-uns des travaux scientifiques par les membres de l'état-major, MM. Matha, Rey, Pléneau, Turquet, Gourdon, Charcot. Paris: Ernest Flammarion. 1906.

Dr. Charcot described his expedition in Antarctic seas so recently to the Royal Geographical Society (vol. 26, p. 497) that it is unnecessary to recapitulate the voyage of the *Français* in noticing this book. The public is no longer a stranger to the usual routine of modern Antarctic exploration, and it is a little difficult to present the record of a new expedition with striking novelty, for the essential incidents repeat themselves for every explorer, the scenery of rock and ice varies little wherever the Antarctic area is invaded, the meagre *fauna* of penguins, sea-birds, and seals is alike whenever it is found, and the perpetual struggle with ice and storm and fog, though full of surprises and teeming with fresh situations to the navigator in the thick of it, is not without a certain sameness when it comes to be written down. Although all this is true, we welcome Dr. Charcot's book, not only as a well-told narrative of an important expedition but also as a notable contribution to Antarctic literature. It is well written, the style being easy without frivolity, and the narrative, though

brightened by many pleasant touches, remains perfectly serious. It is well illustrated; the photographs are carefully selected and excellently reproduced.

A useful part of the book is a detailed discussion of the voyage of the German whaler *Dallmann* in 1873–74, in which Dr. Charcot brings forward evidence to show that the Bismarck strait of that navigator was the southern end of Gerlache strait, and not an opening leading to the Weddell sea.

A series of appendices deals concisely with the scientific work of the expedition. Under geography an account is given of the running survey made of the western side of Palmer archipelago and of the Biscoe islands, the position of which had been by no means exactly determined by their discoverer. Attention is called to the existence of a zone of calms between the westerly winds about Cape Horn and the easterly winds prevailing on the Antarctic side. Magnetic and gravity observations were successfully carried on; the conditions of the ice and geology were not neglected; and various branches of biology were fairly exhaustively studied on the spot and from specimens brought home. The result shows that much good work was done. It is gratifying to know that the *Français*, after being repaired at Buenos Aires, was purchased by the Argentine Government, and under the name *El Austral* is now employed in keeping up communication with the meteorological observatories on various Antarctic islands which were established after the expedition of the *Scotia*.

H. R. M.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Speleology.

'Höhlenkunde, mit Berücksichtigung der Karstphänomene.' By Walther von Knebel, DR. PHIL. Braunschweig: Friedrich Vieweg und Sohn. 1906. Pp. xvi. + 222. 42 *Figs.*, 4 *Plates*. *Price* 5.50*m*.

The author of this work starts with the statement, in his preface, that this is the first truly scientific handbook for the study of caves which has ever appeared. All previous works, according to him, were concerned too much with the description of the form and size of caves, their beauties, and the size of their stalactites, to which were usually added a few speculations on the age and origin of caves. Science, however, has but little concern with the matters to which other treatises on speleology have given the greatest attention and, therefore, he has written a really scientific text-book, in which not so much the facts as their origin and causes are dealt with. Working on these principles, he has produced a work of a type not unknown in this country, in which everything is accounted for in no uncertain manner, for which publishers seem to find a demand, which may help to spread an interest in science, but certainly does nothing to forward the spread of a true scientific spirit. As an example, we may take the treatment of those peculiar swallow-holes, of which the best-known examples are the sea-mills at Argostoli, where the sea-water flows continuously and in volume sufficient to drive two water-mills; various explanations of this strange phenomenon have been proposed, all of which are passed in review and rejected, except one, which is unhesitatingly accepted. This one is a possible explanation, though not proved, and, to our mind, less probable than that of Fouqué, which is summarily rejected; this, however, is merely a matter of opinion, but as none of the suggested explanations has been satisfactorily established, the author's attitude is less scientific than that of M. E. A. Martel, who is gravely rebuked for describing the phenomenon as unexplained. Apart from this fault of over-certain settlement of doubtful problems, the book covers the subject it professes to deal with in a satisfactory manner; in one respect it is more than up to date, as the references to E. A. Martel, the founder of the Société

de Spéléologie, who has written and done so much to advance both the sport of cave-exploration and the study of the caves themselves, consistently refer to him as the late. M. Martel is, fortunately, still alive, and English readers conversant with French will find his larger work, 'Les Abîmes,' or his little book, 'La Spéléologie,' more useful than the book under review, and quite as scientific.

The Ice Age.

'Die Eiszeit.' By Prof. F. E. Geinitz. Braunschweig: 1906. Pp. xiv. + 198. 25 *Figs.*, 3 *Plates*. *Price* 7*m.*

Prof. Geinitz has produced a book of a very different type to the general run of glacialist literature. There is only the slightest reference to the work of ice or the cause of the glacial period; the former extension of glaciers is accepted as a fact, and the work is devoted to a summary of the conclusions which have been formed in all parts of the world by the leading workers at this branch of knowledge, a description of the extent of the Post-Tertiary advances and retreats of glaciers, and of their influence on the scenery of the districts over which they spread. The work may best be described as a careful, concise, and practically complete account of the geographical results of glacial geology.

GENERAL.

Life of Mrs. Bishop.

'The Life of Isabella Bird (Mrs. Bishop).' By Anna M. Stoddart. London: John Murray. 1906. Pp. xii., 416. *Illustrations*. *Two Maps*. *Price* 18*s. net.*

It is fitting that the life of Mrs. Bishop should have been published by the house of Murray, with which she was connected, both as writer and as friend, for close on half a century; and fitting, too, that the task of writing the life should have been entrusted to Miss Stoddart. It was Mrs. Bishop's own wish, expressed a few years before her death, that should there ever come a call for her biography, Miss Stoddart should be the one to undertake the work. The charge has been well and faithfully executed. Miss Stoddart does not weary her readers with long dissertations on the character of her subject, but by the simple recitation of the events of a life singularly full of interest, allows Mrs. Bishop's striking personality gradually to reveal itself.

In some respects Mrs. Bishop was the most remarkable, as it will scarcely be disputed that she was the foremost, lady traveller of the latter half of the nineteenth century. The detailed story of her life emphasizes the impression already made on those who knew anything about her personally, that her journeys represent in a marked degree the triumph of the human will over the effects of disease and bodily weakness. From childhood she was extremely delicate, and throughout her life frequently suffered from prostrating attacks of a spinal complaint. As a leading physician wrote after her death, she was to most people, "if not a mass of physical contradictions, yet very much of a paradox." His explanation is that "Mrs. Bishop was indeed one of those subjects who are dependent to the last degree upon their environment to bring out their possibilities. It is not a question of dual personality, it is the varied response of a single personality under varied conditions." There must, of course, have been a great reserve of endurance, and the existence of this reserve Miss Stoddart attributes to Mrs. Bishop's "splendid digestion." In spite of the serious ailments which exhausted her constitution, her appetite and her power to assimilate large quantities of food healthily never failed until her last illness. She could go for days with little more than a bowlful of rice and a handful of dates or raisins, but when substantial food was to be had she availed herself of it amply.

Her persistent love of travelling is shown by the fact that not the least arduous

of her journeys were undertaken after she had turned her sixtieth year (she was born on October 15, 1831), and after the doctors had pronounced her to be suffering, not only from inefficient action of the heart, but from an affection of the base of one lung. Even so late as the summer of 1903, when she was already in the grips of the illness which finally terminated her life within a few days of her seventy-third birthday, she was busy planning for another journey to China by way of the Trans-Siberian railway. Her interest in missionary work, particularly medical missions, together with the loneliness which characterized her life in spite of numerous friends after the death of her sister in 1880, and of her husband in 1886, after only a very few years of wedded life, no doubt contributed to send her abroad on her later journeys. But Mrs. Bishop was ever possessed with the wanderer's spirit and the desire to get to "the other side of beyond." Even in the heart of China, far up the Yangtse valley, she was consumed with the longing "to break away from the narrow highways, the crowds, and the oppressive curiosity" of China Proper. All with whom she came into contact on her journeys bear testimony to her absolute unconsciousness of fear. Yet she had no lack of imagination, and her keen powers of minute and sympathetic observation added greatly to the geographical value of her work, notwithstanding the absence of any claim on her part to be a "geographer." Only a few months ago, Miss Stoddart relates, "on board a steamer between Japan and Korea, an Englishman asked a Japanese fellow-passenger what modern book would give him the best idea of Japan. 'Bird's *Japan* is the most valuable,' was the answer; 'it describes the interior better than any more recently written.'" It is interesting to note that Mrs. Bishop herself attributed her exceptional powers of observation to her father's "conversational questioning upon everything" while she was still quite a small child. In early childhood, too, she learned to ride, the doctors ordering her to be out in the open air as much as possible, and since "her father knew every wayside and meadow flower, she learned their names, habits, and uses, and felt for them a passionate love" which made her in later years an enthusiastic student of botany, and enabled her to give wonderful detail to the descriptive passages of her books.

A number of portraits and reproductions from some of Mrs. Bishop's own photographs in foreign lands lend additional interest to this account of her life. The two maps which supplement the narrative are hardly worthy of the rest of the volume. The first, comprising the United States and a large part of Canada, seems to us superfluous as a companion to Miss Stoddart's biography; while the second, showing most of Asia, neither has Mrs. Bishop's routes marked on it nor appears to have been prepared in connection with the text, not even such places as Chemulpho, Ichang, Wan-Hsien, and Paoning-fu—to pick a few names out of the book almost at random—being marked on it.

SHORT NOTICES.

Europe.—'From Carpathian to Pindus. Pictures of Roumanian Country Life.' By Tereza Stratilesco. (London: Fisher Unwin. 1906. Pp. xii. and 379. 2 *Maps and Illustrations.*) The subtitle indicates the scope of this work. The affection of the Roumanian writer for her subject is obvious; the book is full of detail and interest, and the photographs are excellent. The geographical description of the country is slight, but the introduction affords a study in the historical geography of Transylvania. A very full use is made of quotations from native songs and poetry, descriptive and narrative.

'Upper Nidderdale, with the Forest of Knaresborough,' by H. Speight (London: Elliott Stock. 1905. Pp. 367 and lxxii. *Map and Illustrations*), is an excellent type of the historico-descriptive works which exist for practically every such district

in England; it is from the pen of a recognized authority on Yorkshire, and bears evidence of deeper research—in the historical direction—than many books of its class. Description of the land is confined mainly to the scenic standpoint.

'A Scientific Geography: Book II. The British Isles,' by Ellis W. Heaton (London: Ralph, Holland. 1906. Pp. 137. *Maps and Diagrams*), is avowedly a "cram" book. As such it may serve its purpose, but can hardly hope to be inspiring in itself, and its utility might have been extended by short bibliographies accompanying the sections. The treatment of railways will bear careful revision.

Asia.—'Arab and Druze at Home.' By William Ewing. (London: T. & E. Jack. 1907. Pp. xii. and 180. *Map and Illustrations.*) This is a simple "record of travel and intercourse with the peoples east of the Jordan." It is not a scientific work, but the scanty knowledge we possess of the land and races of which it treats justifies its existence. The photographs are particularly good, some giving an excellent idea of land-forms and scenery in the Jordan valley.

'Handbook for Palestine and Syria,' new edition (London: Thos. Cook & Son. 1907. Pp. viii. and 424. *Maps*), is a revision of a well-known guide, with good maps by Messrs. W. & A. K. Johnston. It contains explicit information as to the remarkable extension of travelling facilities made by Messrs. Cook in this region.

'The Tourist's India,' by E. Reynolds-Ball (London: Swan, Sonnenschein. 1907. Pp. xii. and 355. *Map and Illustrations*), may be defined as an introduction to the subject of India for the use of visitors. Many centres of interest are described and pictured; superficial indications of some of the political and administrative problems of the empire are given; appendices contain directions as to methods of travel, observations as to health, and the like.

'The Industrial Organization of an Indian Province.' By Theodore Morison. (London: John Murray. 1906. Pp. vii. and 327.) This book would be of service either in the foundation or in the completion of a study of the economic geography of India. It is not in itself geographical, but it deals with the conditions of labour (chiefly agricultural) and accompanying problems.

'The Romance of an Eastern Capital.' By F. B. Bradley-Birt. (London: Smith, Elder. 1906. Pp. x. and 349. *Map and Illustrations.*) The capital in question is Dacca. Much of its history, as told by Mr. Bradley-Birt, undoubtedly deserved the epithet romantic, and the effect is sustained in the lengthy word-pictures of the Dacca of to day.

'Eine Reise durch Vorderasien im Jahre 1904,' by Erich Zugmayer (Berlin: Reimer. 1905. Pp. xii. and 411. *Maps and Illustrations*), deals with an extended journey in Transcaucasia, northern Persia and Khiva, Bokhara, and western Turkestan. The journey did not, of course, break new ground, and the book is mainly narrative. Its most notable feature consists in some remarkable reproductions of paintings from photographs, one of which ("Grabdenkmal bei Khoi") is a real triumph of colour-work. There are, besides, many ordinary half-tones.

'Under the Sun.' By Perceval Landon. (London: Hurst & Blackett. 1906. Pp. xii. and 288. *Illustrations.*) A series of "impressions" by a practised descriptive writer such as Mr. Landon will interest all who take pleasure in this form of writing. The book ranges widely—from Bombay to Mandalay, from the Khyber to Palk strait. Some photogravures raise the illustration-scheme somewhat above the ordinary standard. The book is also made the medium of presenting, for the first time, a brief record of the "later days of Nana Sahib."

'From West to East,' by Sir Hubert Jerningham, K.C.M.G. (London: John Murray. 1907. Pp. xiii. and 351. *Maps and Illustrations*), consists principally of "Notes by the Way" made during a journey which extended round the world. But the book deals chiefly with Japan; its interests are in the main political, and in

some degree military, for the names of Port Arthur and Mukden head successive chapters. In this connection the two maps of military operations round Port Arthur by Messrs. Johnston are particularly clear and graphic of their kind.

'A Cruise through Eastern Seas,' by A. O. Plate, for the Norddeutscher Lloyd Co. (London: Stanford. 1906. Pp. 293. *Maps and Illustrations*), is conceived in a more literary style than the ordinary guide-book. Dealing with places of leading interest to tourists in a round tour embracing Ceylon, Further India, the Malay peninsula and archipelago, the Chinese littoral, Japan, etc., it briefly furnishes information of almost encyclopædic character about each, and should serve its special purpose excellently.

THE MONTHLY RECORD.

EUROPE.

Charles the Great's Passage of the Alps.—In the *English Historical Review* for July last there is an interesting article on the route taken by Charles the Great through the Alps on his march into Lombardy in 773. Hitherto the generally accepted view, based on the authority of the German chronicles, has been that Charles crossed by the Mont Cenis pass. Mr. Coolidge, the author of the article, is able to show, however, that this opinion is probably erroneous, and that Charles really crossed by the Mont Genêvre route. His view is based on the fact that the German chroniclers obviously presumed that Charles followed the route taken by his father, Pippin, some years before, while the only two chronicles which show any knowledge of local topography, those of Novalesa and of Ado of Vienne, distinctly state that Charles went by way of the Mont Genêvre. The question is not one of great importance, but, as the author says, it "offers a certain interest to those students who delight in clearing up small historical puzzles."

Some Features of the Karst.—The latest student to take up the question of the Karst landscape is Dr. I. V. Daneš, who has devoted some time to a thorough examination of the morphological features of the region of the Lower Narenta. He has described the results of his investigations in a detailed report published (in Czech) by the Bohemian Geographical Society, but has made his conclusions more generally available in a German abstract in the *Abrégé du Bulletin de la Soc. Hongroise de géogr.* (1906, No. 8). The first section of the paper is devoted to the "poljes" of the Karst, and Dr. Daneš begins by sketching the views which have been held by recent investigators as to their mode of origin. It may be remembered that Dr. Cvijić attached much importance to the removal of material by chemical agencies, chiefly, as he supposed, along the lines of previously existing dislocations. He also considered that the major axis of the poljes coincided in direction with the strike of the rocks. Dr. Alfred Grund, in his 'Karsthydrographie' published in 1903, contested the views of Cvijić, holding that the lines of fracture had no connection with the mountain structure, but were merely marginal to the areas of subsidence of the poljes. While not denying that some poljes were formed by the removal of waste material, he considered this to take the ordinary form due to mechanical erosion, the poljes in this case being in part at least drained by open-air channels, and thus not belonging to the category of Karst-poljes in the stricter sense. Grund also attached importance to the gradual sinking of the level of the ground-water, as a condition for the origination of the typical Karst landscape. Dr. Daneš, who has investigated several typical Karst-poljes, has come to conclusions differing from those of either of the above writers. He found that the Imotsko

polje, the largest of those examined, is not primarily the result of dislocation and subsidence, but rather of the removal of easily eroded Eocene strata, though tectonic processes and chemical solution may have had their effect later. The Eocene strata have been subject to strong erosion throughout the region, and the writer is inclined to attribute the formation of many other poljes to a similar cause. The second part of the paper discusses the general hydrographical system of the Karst, in regard to which again conflicting opinions have been held, some believing in the existence of regular underground rivers, while others, like Grund, have imagined that there is merely a general percolation of ground-water. Dr. Daneš believes that both forms exist, and that a cycle of development may perhaps be traceable, the underground rivers marking a more mature stage than the percolating ground-water. Their development will, of course, be favoured by the passage of ordinary streams from an area of impermeable to one of permeable strata.

ASIA.

Further News of Dr. Sven Hedin reached this country during March. It seems that before meeting with the first Tibetans at the Bogchang Tsanpo the expedition suffered great privations, not having seen the sign of a human being for 83 days, while of a total of 122 baggage animals only 9 were left when the caravan reached Ngangtse-tso (as the Ngangon-tso seems to be called in the later accounts). The traveller was very favourably received by the Tibetan officials. He reached Shigatse before February 22, having crossed the belt of very elevated plateau, hitherto untraversed, which intervenes between the Ngangtse-tso and the upper Brahmaputra. The watershed is here further north than has been supposed, some big rivers flowing south to the Tsanpo. The country consists of a complicated labyrinth of ranges and ramifications of rivers. From Stanagbo to the neighbourhood of Shigatse Dr. Hedin travelled by boat, and there was a constant stream of boats with pilgrims on their way to attend the New Year festivals at Teshi Lumbo. Here the explorer met with a hearty welcome from the Teshi lama, who made a great impression on him. From Shigatse he was about to set out on a further journey of exploration towards the north-west.

The Pang-gong Lake.—A striking description of the physical phenomena of the Pang-gong lake and its surroundings is given in the *Journal of Geology* (vol. 14, No. 7, 1906) by Prof. Ellsworth Huntington, who spent a short time (May 1 to May 6, 1905) near the lake when setting out with Mr. Barrett on his latest journey to Central Asia. The writer witnessed the break-up of the ice, with which the lake was covered on his first arrival. As the result of a violent wind from the north-west during the night of May 2, the ice entirely disappeared from the centre of the lake for a distance of 8 or 10 miles, part being piled up on the shore in a ridge 8 to 10 feet high. Prof. Huntington watched a sheet of ice in the act of coming ashore, which it did with a steady motion at the rate of 3 feet per minute, pushing up the sandy beach into a ridge. By testing the degree of saltness in the water after, as compared with before, the disappearance of the ice, he came to the conclusion that a large part of the ice had been melted by the salter warmer water which had displaced the surface film of fresh cold water. Prof. Huntington's remarks on the mode of origin of the lake are of special interest, as he believes it to occupy a rock-basin hollowed out by glacial action. As is well known, the lake extends to a great length, occupying, with others of the same series, a valley among the mountains which must have once drained towards the Indus. Early observers, such as Drew (in 'The Jummoo and Kashmir Territories'), had ascribed its formation to the damming of the original drainage by fans from tributary torrents. Prof. Huntington holds that the streams which formed these fans were quite

incapable of obstructing the main stream of the valley, which must have had a considerable volume, and that the fans owed the possibility of their formation to the previous holding up of the drainage. He shows that between the lake and the present divide the valley floor consists almost entirely of solid rock, and that only the (extremely improbable) existence of a gorge, masked by a narrow belt of gravel and lacustrine deposits, could vitiate the conclusion that the basin is terminated by a rock-lip, rising well above the lake-level. The glacial origin is, he says, supported by the abundant evidences of glacial action in the vicinity. The paper treats in some detail of the fluctuations of the lake-level in subsequent periods, as evidenced by lacustrine deposits and shore-lines, which, with numerous old moraines, indicate two extremes of moisture, or at least of lake and glacier expansion, intervening between extremes of aridity or of lake and glacier contraction. The process of desiccation seems to have been oscillatory, and as such oscillations seem to have affected vast areas, they demand the closest study.

Obrucheff's latest Expedition to Central Asia.—In the summer of 1906 this traveller returned to the region of the Tarbagatai, to complete the researches begun during the previous year (*Journal*, vol. **28**, p. 180). A short account of the results appears in the first number of *Petermanns Mitteilungen* for 1907. The region examined lay on the borders of Chinese Dzungaria, and its physical geography and geology had been previously almost unknown. It includes the ranges known as Kojur, Urkashar, Semistai, and Jair, with the adjacent valleys. The former all consist of "horsts," with more or less even surfaces covered with alpine meadows, and of the peneplain type. On certain sides they fall very steeply, and their borders are broken by impassable ravines. The horsts themselves are all composed of Devonian and Carboniferous formations, chiefly clay, quartz, and siliceous slates, but including some sandstones and limestones. On their margins there are intrusive masses of porphyry, melaphyr, etc., while the foothills consist of sandstones, conglomerates, etc., of Mesozoic age. Some traces of former glaciation were seen, and many observations of subaërial denudation, the formation of loess, and the like, were made.

AFRICA.

Scientific Research in German East Africa.—During 1906 two expeditions were sent out to East Africa under the auspices of the "Commission for the geographical investigation of the German Protectorates." The one, under Dr. Fritz Jaeger, was commissioned to carry out geographical researches in the northern part of the territory; the other, under Dr. Karl Weule, had for its main object ethnographical studies in the more southern portion. Information regarding the work accomplished by both expeditions is given in the *Mitteilungen aus den Deutschen Schutzgebieten*, vol. **19**, pt. iv. One section of Dr. Jaeger's journey was referred to in the February number (p. 226, *ante*). After returning from his visit to the Kiniarok steppe, the traveller, with his companion Herr Oehler, of Frankfurt, an experienced alpinist, set out from Moshi for the Kibo peak of Kilimanjaro on August 10, 1906, with the intention of investigating the western glaciers. This was done from a base-camp at a height of a little over 14,000 feet, special attention being devoted to the Penck glacier. Following on a period of copious rainfall, the snow was found to reach down to 15,750 feet, and Dr. Jaeger was able to study the early stages in the production of "nieves penitentes" during the process of melting (cf. *Journal*, vol. **25**, p. 213; vol. **26**, p. 91). He found that the primary ridges on the *firn* surface ran in one constant direction, viz. west-north-west, with no relation to the direction of slope, though this latter determined the breaking up of the ridges into individual "penitentes," apparently under the action of water. While

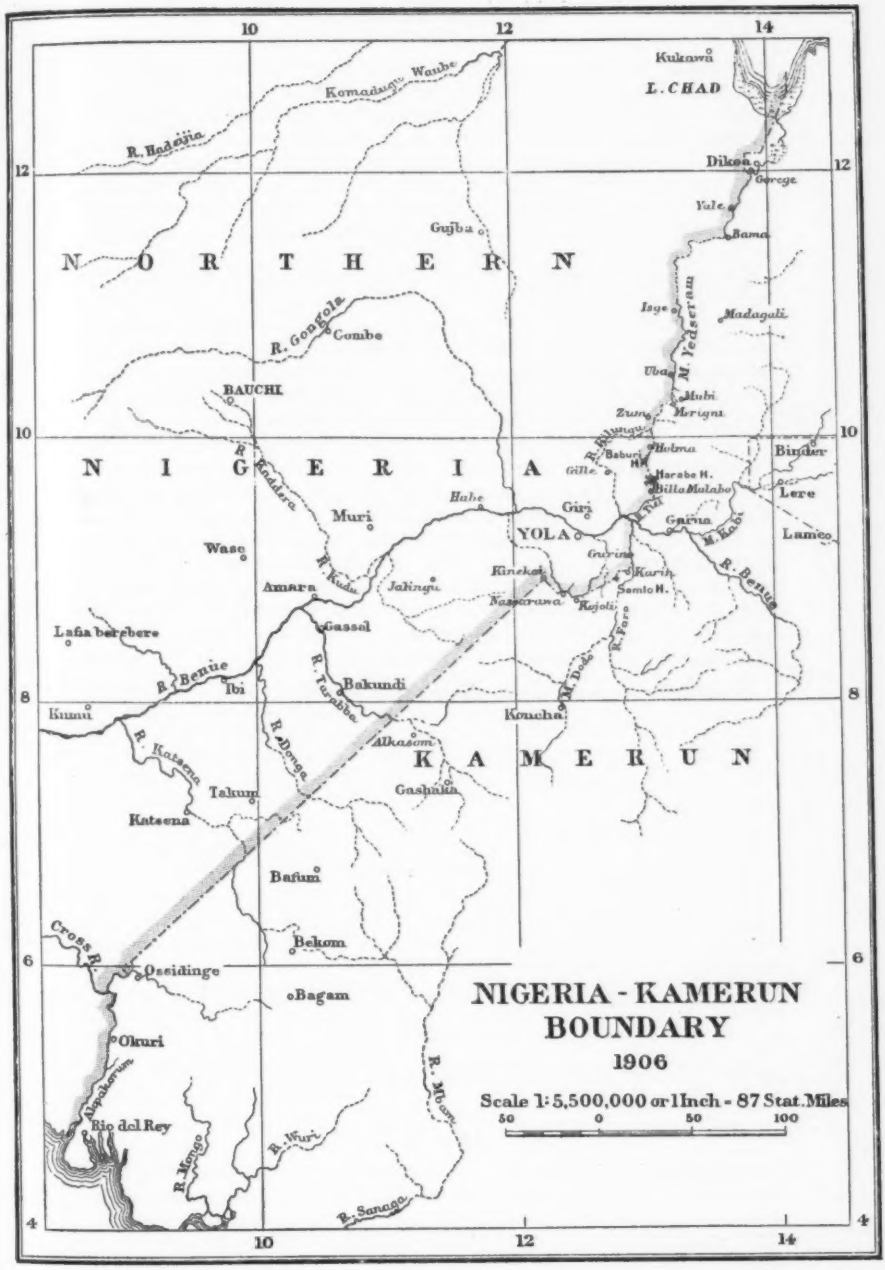
agreeing that the formation of the ridges is due to solar radiation, he is unable to suggest any better explanation than the more or less unsatisfactory ones already put forward. The effects of ice-avalanches on the surface of the snow were also noticed. With a view to future measurement of the rate of flow of the Penck glacier, the travellers marked with red paint a series of rocks stretching across it between points marked on either side. They subsequently made their way to Lake Victoria by way of Umbugwe and Iraku, climbing the Gurui volcano *en route*. They were about to extend their work over the region of inland drainage to the north-east. Owing to disturbances in the Kondoa-Irangi region, Dr. Weule thought it best to change his plans, and carried out some important investigations among the tribes of the extreme south of German territory, north of the Rovuma. He returned to the coast in November last.

The Nigeria-Kamerun Boundary.—The accompanying sketch-map shows the course of the boundary between Nigeria and the Kamerun, as finally fixed by the agreement of 1906 (see *Journal*, vol. **28**, p. 509). That agreement had to do with the northern section of the line, from the neighbourhood of Yola to Lake Chad, no important change having been made in the southern half since it was fixed by the agreement of November 14, 1893.

Proposed Railway from Beira to the Zambezi.—A scheme has been set on foot for a railway to connect the port of Beira with the Zambezi at some point above the portion of the lower river which is so obstructed by shifting sandbanks that navigation is a matter of difficulty. We learn from *South Africa* of February 16 last that a survey of the proposed route is now being made by Belgian engineers. The length of the line would be about 250 kilometres (150 miles), and the terminus suggested is at Lacerdonia, near the confluence of the Shire with the Zambezi, the permanence of the river-bank at this spot being a point in its favour.

Recent Exploration of the Kamolondo.—The Kamolondo, the 400-mile section of the western main branch of the upper Congo from the Kondé rapids (9° 10′ S) to about Hell Gate (5° 20′ S.), was first traced in 1896 by Captain Brasseur. A second and more technical survey was made by Lieut. Lattes, between April and August, 1903. A third survey, just concluded by Lieut. Mauritz, is reported in the *Mouvement Géographique* (1907, No. 7). In accord with Lattes, he finds that the 250 miles of the Kamolondo from Lake Kissale to Hell Gate, with mean breadth of 1600 feet, flows with a deep and regular current between well-marked banks, offering an easily navigable channel. From Lake Kissale, on the other hand, to the Kondé rapids, a stretch of 150 miles, the river winds through a broad low plain, which it inundates by its annual rise. In this region a series of permanent lakes (relics of the former Kamolondo lake), with ill-defined shores, and varying with the river's level, border the principal channel. Here the channel calls for some engineering in order to its utilization. Another Lake No, the Kissale grows papyrus and other aquatic plants obstructive to thoroughfare. These will have to be lastingly cleared out. Here, therefore, will have to be undertaken a work similar to that accomplished in effecting a passage through the sudd of the Nile. On the conclusion of that undertaking, the Kamolondo will be opened to steam navigation across the lake.

The Comoro Islands.—The *Zeitschrift* of the Berlin Geographical Society (No. 9, 1906) contains an interesting general account of the Comoro islands by A. Voeltzkow. All the islands are volcanic, rising steeply from the sea. In the last century there was volcanic activity on Great Comoro, and but a few years ago destructive eruptions occurred. Great Comoro was till recently little known in a scientific sense. In 1863 Dr. Kersten made the first ascent of its high volcano. In 1884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NIGERIA - KAMERUN
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M. Humblot, collector and scientific explorer in Madagascar, was charged by the French Government to make an examination of the island. His mission led to the formation of the "Société de la Grande Comore" for the economic exploration of the island. There was still, however, an ample field for Herr Voeltzkow's scientific exploration. Great Comoro is the largest and highest of the four islands. Whereas Anjuan rises to 5000 feet and Moheli to 2000, Great Comoro reaches 8000 feet. It is 38 miles long by 11 miles in average breadth, and contains two elevated regions. In the south is the mountain mass of Karthala, filling up nearly the whole centre, and with a still active volcano, rising uniformly like a huge dome out of the sea, with flat summit, to 8000 feet. In clear weather the volcano is visible over 100 miles. In the north the ground rises gradually from the coast to an irregular plateau of over 2000 feet, above which numerous bare, regularly shaped cones, with truncated craters, rise to about 4000 feet. These two elevations, north and south, are separated by a depression with an average height of about 1600 feet, forming an enormous desert field of younger lava-streams, intersected by paths communicating between the east and west. The coast region of the Karthala *massif* up to 2000 feet is the cultivated zone, occupied by coconut palms, banana groves, mangoes, plantations of vanilla, cacao, coffee, etc. Above, up to 6000 feet, is the great moist primitive forest. The summit is covered with high grass and low bush, presenting steppe-like meadows. The climate is tempered by the insular situation and the prevailing winds. The north-east rain-bringing monsoon begins at the end of October, and is often squally. The south-west monsoon is steady, and yields occasional showers; but November to March is the rainy season proper. On the upper slopes of the high volcano there is continuous rain on the weather side. Particularly interesting are Dr. Voeltzkov's remarks on the history of the settlement and the anthropology of the islands.

Migrations in the Ogowe Basin.—The importance of the study of the migrations of primitive peoples cannot be overestimated, and Lieut. Avelot has done great service, particularly to anthropologists, in publishing, in the *Bulletin de Géographie Historique et Descriptive* (vol. **20**, p. 357), a careful account of the movements of the peoples dwelling in the basin of the Ogowe and the adjacent country. From the records of old travellers, from native traditions and from personal observations, M. Avelot has reconstructed the past history of these tribes—the most important of which are the Bakalai, Fiottes, and Pahouins or Fans—and has been able to trace their movements for several generations. The value of the paper is greatly increased by a series of excellent maps, showing the positions of the tribes at different periods, and by two sets of tables—one an attempt at a classification of the peoples in the Ogowe basin, and the other a short comparative vocabulary of thirty-five dialects spoken in the French Congo, and of eleven other African tongues. The paper is one of the most important and useful that has appeared for some time, and it is to be hoped that M. Avelot will be able to carry out similar investigations among other peoples.

Note on Ruwenzori: Erratum.—In the March *Journal*, p. 329, line 1, for "Mount Baker" read "Mount Speke."

AMERICA.

The Malaspina Glacier.—In *Science* of January 4, 1907, Prof. R. S. Tarr calls attention to the remarkable changes which had taken place in some of the glaciers which debouch on the great Malaspina ice-field during the ten months which elapsed between his visits of 1905 and 1906. In the former year the surface of these glaciers offered no greater obstacles to easy travel than they had at

the time of the expeditions of Russell, Bryant, and others to Mount St. Elias, while in the latter they were so crevassed, owing to a rapid forward movement of the ice, as to be almost impassable. A striking contrast, however, was afforded by others of the glaciers, which showed practically no change during the same interval. Similar phenomena were displayed by the glaciers entering Yakutat bay, some of which showed a marked advance, while others had remained stationary. The writer thinks that these facts are not to be accounted for by ordinary climatic variations, but suggests that the severe earthquake shocks which visited this region in 1899, and which caused a sudden uplift of the coast-line in Yakutat bay (see *Journal*, vol. **28**, p. 30), or possibly some previous earthquake, may have shaken down unusual quantities of snow and ice from the mountains near the head of some of the glaciers, thus starting a wave of advance. The suggestion is certainly ingenious, though even if earthquake shocks may have been the cause of the advance, the method of action referred to does not seem to be the only one capable of producing the given effect. Might not these have resulted, *e.g.*, from an alteration of the slope of the ground beneath the ice, possibly at the time of the disturbances of 1906? Anyhow, as Prof. Tarr says, it will be a matter of great interest to carefully watch the behaviour of all these glaciers during the next few years.

The New Salton Sea.—The recent formation of a lake of considerable area in the Salton depression, owing to the irruption of water from the Colorado river through irrigation channels, has already been referred to in the *Journal* (vol. **27**, p. 631), and was also discussed by Major Beacom in the paper on irrigation lately read before the Society. From a paper by Mr. C. A. Byers in the January number of the *Popular Science Monthly* of New York, it seems that the control of the overflow from the Colorado is a matter of much greater difficulty than has been supposed. Mr. Byers discusses the possibilities of a permanent alteration in the geography of this region, and points out that any advantages which might be supposed to accrue from the existence of an inland sea in the arid tract north of the Gulf of California could hardly outweigh the loss of so large an area of irrigable land. Owing to the damage caused to the Southern Pacific Railroad by the irruption of the Colorado, the work of controlling the river was taken in hand by the company, and the various attempts to secure the mastery, each more determined than its predecessor, are described in the paper referred to. After six failures, a seventh attempt, involving an outlay of $40,000, was commenced early in 1906, and seemed for a time likely to be successful. But a postscript to the paper records the fact that on December 7 last the river once more broke through, the conditions becoming as bad as six months previously, and the possibilities of a permanent Salton sea more pronounced than ever. The recent break occurred just below the new dyke, which had a length of over 10 miles, and has already excavated a cañon-like channel in the easily eroded material of the river-bank. To ensure success, about 20 more miles of dyke would be needed, and this, too, would have to be built without delay. The article is illustrated by photographs of the various channels and controlling works. It may be mentioned that a somewhat abnormal amount of rainfall in the extreme west of the United States has been attributed by popular imagination to the Salton inundation, but it need hardly be said that such ideas can have little scientific basis.

Expeditions to the Pilcomayo.—The German engineer, W. Herrmann, last year undertook an expedition for the examination of the middle course of the Pilcomayo, which, though the goal of many exploring expeditions, has hitherto been imperfectly known. According to a communication from the traveller printed in the *Zeitschrift* of the Berlin Geographical Society (1906, No. 10) this object was successfully accomplished, the course of the river being followed from 22° to 24° S.,

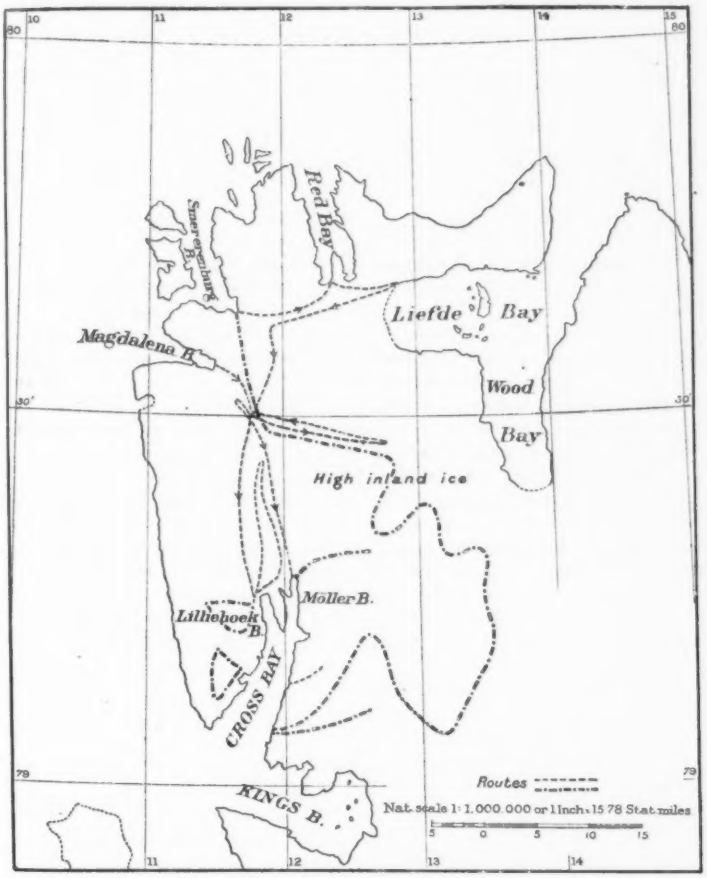
though, on arriving at about the latter parallel, it was found impossible to continue the journey owing to the splitting up of the river into many shallow channels, and the swampy nature of the flat country on either side. The greater part of the descent was accomplished in a "chalana" or covered boat, 20 feet long. The river, between the parallels mentioned, consists of a single channel only, without rapids, and navigable for small vessels. The banks were at first 30 to 40 feet above the water, but became gradually lower, being in places only 3 feet high. The river was exceptionally low at the time. The whole middle and lower course of the Pilcomayo, from 22° S. to its mouth, has also been surveyed within the last two years by a party from the side of the Argentine under Mr. G. Lange, but the German traveller does not seem to have met the latter. An account of Mr. Lange's expedition, with a map of the river in seven sheets, on the scale of 1 : 100,000, has quite lately appeared in Buenos Aires.

The Distribution of Earthquakes in Chile.—The well-known Italian seismologist, Dr. M. Baratta, brings together the historical data bearing on this question in the January number of the *Bolletino* of the Italian Geographical Society, giving, besides, a map showing the general distribution of the earthquakes. While no general conclusions are presented by the writer, the facts adduced show how all the great earthquakes in this much-disturbed region have tended to be concentrated within definite areas, the zones of greatest seismic activity lying at intervals along the coast-line, from the Peruvian frontier in the north to Valdivia in the south. For frequency of destructive earthquakes, the portion of the coast from Caldera and Copiapo in the north to Coquimbo in the south seems to be particularly prominent, while the tract with Valparaiso as centre stands out for the violence of the destructive agencies. As a rule, Valparaiso has lain within the zone of greatest destruction, while Santiago has suffered less, though the case is occasionally reversed. Chile also feels the influence of the unstable zone of Mendoza in the Argentine, but the destructive effects are in this case extremely limited. It may perhaps be questioned how far the spaces between the zones laid down are really less subject to seismic disturbance, and whether their apparent freedom may be due in part to the paucity of centres of population where the destructive effects would be seen.

POLAR REGIONS.

The Prince of Monaco's Expedition to Spitsbergen.—We have received the following communication from Captain G. Isachsen: "I have delayed answering your letter of September 29, 1906, until H.S.H. the Prince of Monaco, who fitted out the expedition, had presented his 'Campagne Scientifique' to the Academy of Science in Paris. I now send you a note stating briefly what ground we have covered. I am now working out a map of the region explored—one-half on the scale of 1 : 100,000, the other half 1 : 50,000. The expedition consisted of seven men under my command. (1) Between July 14 and 19 the preliminary topographical work was carried out at Cross bay. (2) Between July 20 and August 15 the traverse of New Spitsbergen was effected by two parties—the one coming down at the mouth of Cross bay, the other at Müller bay. Afterwards one of the parties traversed another line from Magdalena bay to Lilliehook bay. (3) August 15 to August 30 smaller trips in the interior completed the work. We found the most part of the interior of New Spitsbergen covered with ice; a large ice-plateau south of Liefde bay drains to this bay, but mostly to Kings bay. The height of this plateau was from 800–1000 metres above the sea. The geologist has collected specimens, and will work out a map of the geology of this part of Spitsbergen.

The erosion is very great. The soil is not solid enough to bear vegetation. The temperature of the air varied between 8° and −7° C. The topographical work has



SKETCH OF PART OF SPITSBERGEN, SHOWING ROUTES TRAVERSED BY THE PRINCE OF MONACO'S EXPEDITION.

been done largely by the photogrammetric method, and we have thus a large quantity of excellent photos."

Mr. Mikkelsen's Expedition.—Mr. Mikkelsen has sent us a statement of the position and prospects of his expedition at the end of last September, together with a discussion of the evidence which seems to point to the existence of land not far from the north coast of Alaska. The passage of Point Barrow (*Journal*, vol. **28**, p. 403) was only effected through the aid courteously rendered by Captain Cottle of the steam-whaler *Belvedere*, who took the *Duchess of Bedford* in tow. Otherwise it would hardly have been possible for a sailing vessel such as Mr. Mikkelsen's

to pass the point in the teeth of an adverse wind and strong current. Winter quarters were finally selected at Flaxman island, after vain attempts to push further east, and Mr. Mikkelsen thought that this spot would prove an advantageous base for the exploration of the Beaufort sea by sledge-journeys during the spring. From his own observations, and from careful inquiries among the whalers, his belief in the existence of land to the north has been much strengthened. He has convinced himself of the heavy nature of the ice of the Beaufort sea, and of its general nearness to the land. At Point Barrow it does leave the coast in normal years, but further east, towards Cross island, it seems to be almost permanent, though still further in the same direction, off Herschel island, there is nearly always open water quite early in the year. After alluding to the land reported by Captain Keenan, who is said by the whalers to have been a thoroughly reliable man, and to Eskimo legends pointing in the same direction, Mr. Mikkelsen lays stress on the existence, year after year, of a great crack in the ice, which is used by the whales in their annual migration to north-east towards the end of May, between which date and July they are never seen on the coast. Migratory birds also pass annually in the same direction, evidently to some unknown breeding-ground. By a trip over the ice north of the winter quarters during the present spring, and another in 1908 from Cape Prince Alfred on Banks Land, Mr. Mikkelsen hopes to set at rest the question of the existence of land in this locality.

Dr. Charcot's New Expedition.—We have received from Dr. Charcot a brief statement of his plans for a new expedition to the Antarctic for the purpose of continuing his researches in the Graham Land region. At the explorer's request, a committee was lately appointed by the Academy of Sciences to consider the question, and as a result of its favourable report the Academy, on February 4, decided to support his proposals for a second French Antarctic expedition. The following is an outline of the provisional programme. A vessel will be specially built for the purposes of the expedition, possibly at Dr. Charcot's own expense. The explorer and his companions would proceed in the spring to the site of the rich deposits of fossils discovered by the Swedish expedition at Mount Bransfield and Seymour island, and, having either returned to Ushuaia with the collections or left them at an accessible spot in the region to the south, would, from Wandel island as a base, extend the explorations carried out during the first expedition to the unknown region south of Loubet land. The expedition would winter at a suitable spot, making journeys along the coasts and into the interior, with a view both to scientific observations and a general reconnaissance of the region to the south. During the following summer the voyage would be resumed according as circumstances dictated. Scientific work of all kinds would be kept up throughout the course of the expedition. Dr. Charcot calculates the probable expense, including the cost of the ship, at not over £30,000.

GENERAL.

Masudi on Volcanoes.—An article in the *Journal of the Bombay Branch of the Royal Asiatic Society* (vol. 22, No. 61) brings together the statements respecting volcanoes made by the Arab historian Masudi (tenth century A.D.). As the historian travelled as far as the Malay peninsula and the Chinese seas, his views, embodied in 'Meadows of Gold and Mines of Jewels,' may be taken to be based on personal observation. He speaks of volcanoes in the most distant islands in the Sea of China, which the author of the article takes to be those of Java and Sumatra. In dealing, too, with the volcanic belts of the Caucasus (long extinct) and of Sicily, Masudi refers to the volcanoes in the kingdom of the Maharajah, which may be identified as those of Java and Sumatra, then under a Maharajah, and to the volcano

of "Zabej" (Java ?) in the Sea of China. The volcano of Sicily is called "Jabal al Barkan." He also speaks of the volcano of "Wadi Berhout in Hadramaut," and of that of "Esk (Eskibun) in the country of Fars," and of the hot springs of sulphur and vitriol in the province of Sirwan. So much for Masudi's geographical field. His vulcanology is still anthropomorphic. From volcanoes "emanates a frightful voice announcing the death of a king or chief." He also speaks of "the sound of drums, flutes, lutes," etc. A volcano is also a "hill," or seat, of punishment for the wicked.

OBITUARY.

Dr. Alfred Kirchhoff.

Dr. Alfred Kirchhoff, one of the best known and most successful workers in the cause of geographical education in Germany, died on February 8, 1907, at the age of sixty-nine years. Towards the end of 1904 he had been forced, by failing eyesight, to resign the professorship at Halle University, which he had held for thirty-one years, and his powers had since gradually declined, the end being, perhaps, hastened by the results of a fall in the autumn of last year.

Kirchhoff will be remembered, side by side with Ratzel and Richthofen, as one of the band of successful teachers to whom the present satisfactory position of geography in Germany has been mainly due. During his whole career as professor his stimulating influence had been felt by a constant succession of pupils, who have themselves become centres for the propagation of his ideals and methods in many different parts of Germany; and the universal regard and affection which they have constantly testified towards him supply one of the best testimonials to the importance of his work. His competence as a geographer was due in great measure to the many-sided character of his interests, which well qualified him to deal with a subject which forms, like geography, a link between the sciences of nature and man. Born at Erfurt in 1838, he completed his education at the universities of Jena and Bonn, where he paid attention alike to natural science, history, philology, and other subjects. For some years he worked as a teacher in various schools, and the experience so gained no doubt did much to qualify him in later years to deal with the needs of geographical education in all grades. Among his most important services to this cause were the various educational works which came from his pen, especially the 'School Geography,' which first appeared in 1882; while his contributions to a clearer understanding of the scope and possibilities of the subject as an educational instrument were no less valuable. It was to the regional side of geography—the presentation of a complete picture of a given country under all its aspects—that he attached especial importance, as was evidenced by his zealous furthering of regional studies in Germany, which had its outcome in the excellent work of the "Centralkommission für wissenschaftliche Landeskunde von Deutschland For twenty years Kirchhoff edited the well-known collection of monographs, brought out under the auspices of this body, with the title 'Forschungen zur deutschen Landes- und Volkskunde.' He was also responsible, with others, for the periodical reports on the literature of German geography. A work of wider scope was the series of monographs on the geography of Europe, written by various experts under his general editorship, and originally planned, under the title, 'Unser Wissen von der Erde,' to form part of a descriptive geography of the whole world.

Among Kirchhoff's shorter writings were various papers on the geographical and political relations of mankind, which bore witness to great insight and breadth of view. Among these were a study entitled 'Das Meer im Leben der Völker'

(originally delivered as an address to the "Institut für Meereskunde" at Berlin), and another on the ideas 'Nation' and 'Nationality.' A small volume of sketches of this character has lately been translated into English under the title 'Man and Earth' (Routledge's 'New Universal Library,' 1906).

CORRESPONDENCE.

Fall in Level of Central African Lakes: Lake Nyasa.

In the *Journal* for December, 1906, there appeared a letter from Mr. William Piercy on this interesting subject, in which he pointed out the fact that Lake Nyasa has been falling for a period of ten years, and enclosed a photograph of the marks painted on the rocks at Monkey bay, showing the level of the lake in different years since 1897.

The level of Lake Nyasa has been more or less steadily falling for a much longer period than ten years. My own experience of it goes back twenty—to 1887; and for some eight or ten years before that, the lake and upper Shire river was navigated by the Scotch Free Church Mission steamer *Ilala*.

With regard to the twenty-years period of which I have personal knowledge, the level of the lake in 1887 was considerably higher than that registered on the rocks at Monkey bay in 1897. The fall for some years previous to 1887 appears to have been more or less steady. In Livingstone's time a steamer drawing 6 feet of water could travel up the Zambezi and Shire rivers as far as Chiromo, and the level of the Shire river depends entirely upon the level of Lake Nyasa. At the present date the Shire at Chiromo has almost ceased running.

Mr. Piercy speaks of "a period of desiccation." This, I think, is a misleading description of the present climatic conditions in British Central Africa. There is nothing which could be described as "desiccation." The basin of Lake Nyasa (as in the case of all other Rift lakes of Central Africa) is an extremely limited one; consequently, if the rainfall within that limited area happens be in any year a low one, the result is that the lake fails to have its normal rise. The great bulk of water entering Lake Nyasa comes in at the north end. On the east there is no river of consequence, and on the west the few comparatively large streams, such as the Rukuru, Bua, Loangwa, and Lilongwe, are mostly dry by the month of August, and remain in that condition until December. Rainfall records kept at Zomba, in the southern portion of the British Central Africa Protectorate, distant 60 miles from the south end of Lake Nyasa (outside the Nyasa basin) are as follows, for the past twelve years:—

1895	49·92
1896	63·34
1897	46·36
1898	63·83
1899	60·89
1900	42·87
1901	50·41
1902	48·52
1903	49·35
1904	74·13
1905	57·78
1906	39·46

From this it will be seen that immediately south of the Nyasa basin there

cannot be said to have been any marked falling off in the annual rainfall, which is curious.

There is, I think, little doubt that both in the Tanganyika and Nyasa basins there are lengthy periods of both ample and deficient rainfall. With regard to Tanganyika, we know (*a*) that when Livingstone and Stanley circumnavigated the lake, the Lukuga river had no outlet, and it was clear that the lake had not run out at the Lukuga for many years previously. (*b*) It is also known that at some previous period the lake *had* its outlet at the Lukuga. (*c*) We know that not long after Stanley's visit, the lake again broke out at the Lukuga river. (*d*) Of recent years the level of Tanganyika has fallen again, and if the Lukuga has not already quite closed up it is highly probable that it will do so very soon.

Lake Nyasa has, I feel sure, in the past had similar periods, and I think it reasonable to suppose that the Shire river, the outlet of the lake, has in previous history closed up and re-opened in the same way that the Lukuga has. More than a year ago I stated the opinion that if the present deficient rainfall period continued for a year or two, we should see the Shire close at Fort Johnston, where the lake has its exit. At the present date there are only a few inches of water. Last year, at the termination of the dry season, and before the rains had caused the lake to rise, but when the first local rain arrived, the curious sight was seen of streams running into the upper Shire and flowing north, "up" the course of the river *into* Lake Nyasa, instead of in the usual direction to the south.

Mr. Piercy is apparently of opinion that if the "channel of the upper Shire" were by some means cleared out or dredged, this river would, in spite of the present condition of Nyasa, continue to be a navigable waterway. Unfortunately, as Nyasaland knows to its cost, the reason why this river is practically ceasing to be a waterway is, not that there are any serious obstructions or "siltings up" in its channel (which is some 300 miles in length), but because there is no water coming out of Lake Nyasa to run down that channel. It is obvious that the best of channels is of little use if there is no water to fill it. The condition of the lake now is that it has almost ceased to run over at its exit at the south end. The only possible means of obtaining a larger supply of water from the lake would be if there were some description of abrupt lip at the exit which could be lowered by excavation. Even this, as I need hardly point out, would have to be done year after year so long as the lake continued to fall. As a matter of fact, however, any such lowering is beyond human power. The lake has no abrupt lip. There is practically no fall on the upper Shire river from the point of its exit, down to the settlement of Liwonde (a distance of 60 miles), the difference in level being only a few feet.

In default of a permanent rise in the level of Lake Nyasa, the only means by which the Shire river could be made permanently navigable, would be the erection of a gigantic dam at the south end of the lake, which would hold up all surplus water during the height of the rainy season, with vast sluices through which the water could be passed during the dry season. Such a work would cost many millions sterling, and is clearly out of the question.

Mr. Piercy also speaks of "afforestation," presumably as a means of increasing the rainfall in the Nyasa basin. There has been no deforestation in this region. Patches of native cultivation form a very small percentage of the area, which is covered with the usual East Central African "bush" (somewhat stunted forest growth). European cultivation or forest-clearing in the Nyasa basin is as a pin-prick on the map. I have no hesitation in saying that this has no bearing on the fall in level of Lakes Nyasa and Tanganyika.

ALFRED SHARPE.

British Central Africa, January 27, 1907.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1906–1907.

Eighth Meeting, February 25, 1907. Colonel G. Earl Church, Vice-President, in the Chair.

Elections.—*Alfred Baker; Charles John Baker; Colonel H. Bower, I.A.; Harold Nunes Carvalho; Robert Lorimer Corbell; Major-General H. R. Courtenay, R.A.; James Curle; Captain H. R. Done; Alfred H. Garlick; Kynard Hawdon; Frederick David Charles Shaw Kennedy; Dr. Norman Maclaren; Commander Charles E. Monro, R.N.; Lieut. Charles F. Nunneley; John Parker; James Parsons; Arthur Ingram E. Smith; Konojo Tatsumi.*

The paper read was:—

"Inland Waterways." By George G. Chisholm, M.A.

Research Department.

March 8, 1907.—Major C. F. Close, C.M.G., R.E., in the Chair.

The paper read was:—

"Physical Features of the Morphology of Turkestan." By W. Rickmer Rickmers.

Ninth Meeting, March 11, 1907.—The Right Hon. Sir George T. Goldie, K.C.M.G., D.C.L., LL.D., F.R.S., President, in the Chair.

Elections.—*Lieut.-Colonel T. H. A. Anderson; Hy. Bryant Bigelow; P. L. Blyth; Charles Calvert Bowring; Richard Hugh Royds Brocklebank; Ernest H. Casey; Elmer L. Corthell; Colonel E. Dickinson, R.E.; Hastings Russell Eastcott; Albert Ezra Neale; Captain Lord Bernard Gordon-Lennox; Captain Lord Esme Charles Gordon-Lennox; Henry Douglas Morpath Haszard; Robert Ernest Hills; Thos. Jowett; Alan Collingwood Knight; Lieut. D. Pudsey; Lieut. I. D'Esterre Roberts, R.A.; F. Stanley Service; Miles Staniforth Cater Smith; I. A. Stigand; Mark Sykes; Le Comte de Valhermey.*

The paper read was:—

"Journeys in Northern Mesopotamia." By Mark Sykes.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendes.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Balkan Peninsula. **Cvijic.**

Sketch of the Geography and Geology of Macedonia and Ancient Servia, with observations on Southern Bulgaria, Thrace, the neighbouring regions of Asia Minor, Thessaly, Epirus, and Northern Albania. By J. Cvijić. 2 vols. [In Servian.] Belgrade, 1906. Size 13 × 9½, pp. viii. and 690. *Maps and Illustrations. Presented by the Author.*

Germany—Minerals. **Bruhns, etc.**

Die nutzbaren Mineralien und Gebirgsarten im Deutschen Reiche. Auf Grundlage des gleichnamigen v. Dechenschen Werkes neu bearbeitet, unter Mitwirkung von H. Bücking, durch W. Bruhns. Berlin: G. Reimer, 1906. Size 9 × 6, pp. xx. and 860. *Map. Price* 16*s.*

A carefully revised edition of the work brought out by Von Dechen in 1873. The geological introduction has been re-written, and the special sections thoroughly revised and rearranged for facility of reference. The work forms a valuable handbook on the mineral resources of Germany.

Germany—Würtemberg. **Gugenhan.**

Der Stuttgarter Talkessel—von alpinem Eis ausgehöhlt! Von M. Gugenhan. Berlin: R. Friedländer & Sohn, [*not dated*; 1906]. Size 10½ × 7, pp. 26. *Maps. Price* 2*s.* 3*d.*

Holland—Fisheries. *Rev. Maritime* **170** (1906): 395–416. ———

La pêche hollandaise dans la mer du Nord et dans le Zuiderzée. (Rapport du vice-consul de France à Rotterdam, 11 Octobre, 1905.)

Hungary—Place-names. *Abrégé B.S. Hongroise G.* **34** (1906): 105–107. **Buday.**

Grundbuch der Ortsnamen Ungarns. Von Dr. L. Buday. (*Földrajzi Kozlemények* **34** (1906): 224–229.)

Hungary—Water-power. *Abrégé B.S. Hongroise G.* **33** (1905): 131–141. **Vicrián.**

Ueber die Wasserkräfte Ungarns. Von Eduard Viczian (*Földrajzi Közlemények*, **33** (1905): 387–403. *With Maps and Illustrations.*

Italy—Vesuvius. *Science* **24** (1906): 284–286. **Eastman.**

Disputed Vesuvian Eruptions. By Dr. C. R. Eastman.

The writer sees no reason to doubt the eruption of the early sixteenth century mentioned only by Ambrogio di Leone.

Italy—Vesuvius. *Quarterly J. Geol. S.* **62** (1906): 476–483. **Lorenzo.**

The Eruption of Vesuvius in April, 1906. By Prof. G. de Lorenzo. *With Map and Illustrations.*

Norway—Landslip. *B.S.G. Philadelphia* **4** (1906): 46–50. **Brigham.**

A Norwegian Landslip. By Albert Perry Brigham. *With Map.*

The writer visited the site of the disastrous catastrophe of January 15 1905, six months after it occurred.

Rumania. **Stratilesco.**

From Carpathian to Pindus: pictures of Roumanian country life. By Tereza Stratilesco. London: T. Fisher Unwin, 1906. Size 8½ × 5½, pp. xii. and 380. *Maps and Illustrations. Price* 15*s. net. Presented by the Publisher.*

See note on p. 453.

Russia—Finland—Fisheries. **Sandman.**

Conseil Exploration Mer, Publ. Circonstance, No. 13c (1906): pp. 139–188.

Die Ostseefischerei in ihrer jetzigen Lage. (Dritter Teil.) IV. Uebersicht ueber die Seefischerei Finnlands, ausgearbeitet von J. A. Sandman. *Maps and Plates.*

Servia—Phytogeography. *Petermanns M.* **52** (1906): 169–173. **Adamović.**

Zur pflanzengeographischen Karte von Serbien. Von Prof. Dr. L. Adamović. *With Map.*

Noticed in the Monthly Record (January, p. 85).

Sweden—Norrland. **Högbom.**

Norrland; Naturbeskrifning. Af A. G. Högbom. (Norrländskt Handbibliotek. I.) Upsala, etc.: Almquist & Wiksell, [1906]. Size 10½ × 7½, pp. xvi. and 414. *Maps and Illustrations. Price* 6 *kr. Presented by the Author.*

An exhaustive monograph on the province, its geology, geography, vegetation, animal life, etc., with an historical sketch illustrating the development of knowledge of it on the part of the outside world. It will be reviewed in a subsequent number.

Switzerland—Industries. *M. Antiquar. Ges. Zürich* **26** (1906): 155–210. **Lehmann.**

Zur Geschichte der Glasmalerei in der Schweiz. I. Teil: Ihre Entwicklung bis zum Schlusse des 14. Jahrhunderts. Von H. Lehmann. *With Illustrations.*

Switzerland—Settlements. *Ann. G.* **15** (1906): 329–352. **Brunhes and Girardin.**

Les groupes d'habitations du Val d'Anniviers comme types d'établissements humains. Par J. Brunhes et P. Girardin. *With Map and Illustrations.*

Turkey—Macedonia. **Struck.**

Makedonische Fahrten. Von A. Struck. I. Chalkidike. (Zur Kunde der Balkanhalbinsel. Reisen und Beobachtungen, herausgegeben von Dr. C. Patsch. Heft 4.) Wien und Leipzig: A. Hartleben, 1907 [1906]. Size 9½ × 6½, pp. 88. *Maps and Illustrations. Price* 2*m.* 25. *Presented by the Publisher.*

United Kingdom. **Mackinder.**

Britain and the British Seas. By H. J. Mackinder. Second Edition. ('The Regions of the World' Series.) Oxford: Clarendon Press, 1907. Size 9 × 6, pp. xii. and 376 *Maps. Price* 7*s.* 6*d. net. Presented by the Publishers.*

Reviewed in the March number (p. 334).

United Kingdom—Devon. **Clayden.**

The history of Devonshire scenery: an essay in geographical evolution. By Arthur W. Clayden. London: Chatto & Windus (Exeter: J. G. Commin), 1906. Size 9 × 5½, pp. 202. *Maps and Illustrations. Price* 10*s.* 6*d. net.*

An attempt to reconstruct the geography of Devonshire at successive epochs in the past.

United Kingdom—Geology. *Quarterly J. Geol. S.* **62** (1906): 132–164. **Jukes-Browne.**

The Clay-with-Flints; its Origin and Distribution. By A. J. Jukes-Browne. *With Sections.*

The writer regards the "clay-with-flints" which often overlies the chalk, as in the main residual material derived from the "Reading beds" (Eocene), though some of its contents may have their origin in the chalk.

United Kingdom—Mersey. *P.R.S., Ser. A*, **78** (1906): 161–166. **Shoolbred.**

The Tidal Régime of the River Mersey, as affected by the recent dredgings at the Bar in Liverpool Bay. By J. N. Shoolbred. *With Plan.*

United Kingdom—South-West England. **Snell.**

The Blackmore Country. By F. J. Snell. London: A. & C. Black, 1906. Size 8½ × 5½, pp. xxiv. and 288. *Map and Illustrations. Price* 6*s.*

Western Europe—Stone Age. *B.S.G. Com. Bordeaux* **32** (1906): 230–236. **Paniagua.**

Note sur le Moustérien dans l'Europe Occidentale. Par A. de Paniagua.

On the flint implement industry, known by the above name.

ASIA.

China—Sechuan. **Abendanon.**

La géologie du Bassin rouge de la province de Se-tchouan (Chine). Par E. C. Abendanon. The Hague: M. Nijhoff, 1906. Size 9½ × 6½, pp. 200. *Maps and Sections. Price 5s.*

A useful addition to our knowledge of the geological structure of the "Red basin" of Sechuan, based on the writer's personal observations, though account is, of course, taken of the work of Richthofen, Leclère, and others.

India—Central Provinces. **Russell.**

Central Provinces District Gazetteers. 13 Volumes; Statistical Tables (1891–1901). Edited by R. V. Russell. Districts of Balaghat, Betul, Bhandara, Bilaspur, Chanda, Chhindwara, Damoh, Hoshangabad, Jubbulpore, Mandla, Nagpur, Narsinghpur, Nimar, Raipur, Saugor, Seoni, and Wardha. Allahabad, 1904–1905. Size 8½ × 6½. *Presented by the India Office.*

India—Himalaya. **Oestreich.**

Petermanns M., Ergänzungsheft **155** (1906): pp. viii. and 106.

Die Täler des nordwestlichen Himalaya. Beobachtungen und Studien von Dr. Karl Oestreich. *With Map and Illustrations.*

India—Historical. **Foster.**

The English factories in India, 1618–1621. A calendar of documents in the India Office, British Museum, and Public Record Office. By William Foster. Oxford: The Clarendon Press, 1906. Size 9 × 6, pp. xlviii. and 380. *Map. Price 12s. 6d. net. Presented by the Publishers.* [To be reviewed.]

India—Language. **Wickremasinghe.**

Marlborough's Self-taught Series, No. 19. Tamil Grammar Self-taught. (In Tamil and Roman characters.) By M. de Zilva Wickremasinghe. London: E. Marlborough, 1906. Size 7½ × 5, pp. 120. *Price 5s. Presented by the Publisher.*

India—Punjab.

Punjab District Gazetteers, vol. **13** A. Hoshiarpur District, Part A, 1904. Lahore, 1905. Size 10 × 7. *Maps. Presented by the Indian Government.*

Indian Ocean—Maldive Islands. *Indian Antiquary* **34** (1905): 251–252. **Perera.**

A Note on Maldivian History. By A. A. Perera.

Japan. **Papinot.**

Dictionnaire d'histoire et de géographie du Japon. Par E. Papinot. Tōkyō: Lib. Sansaisha; Yokohama, etc.: Kelly & Walsh. [1906.] Size 9 × 6, pp. xviii. and 992. *Maps (in separate cover) and Illustrations. Price 16s. 6d.*

The first attempt yet made to supply an encyclopædia of our knowledge of Japan. A considerable proportion of the headings are place-names.

Japan—Formosa. *J. Tokyo G.S.* **18** (1906): 246–257, 291–314. **Ōshima.**

A Sketch of Eastern Taiwan. By Jūrō Oshima. *With Sketch-maps.* [In Japanese.]

Japan—Iwashiro. *J. Tokyo G.S.* **17** (1905): 882–888. **Tanaka.**

On the Lake Yukunakinuma, Iwashiro Province. By Akamaro Tanaka and Hirosaku Tanaka. *With Sketch-map and Diagrams.* [In Japanese.]

Japan—Lake Yamanaka. *J. Tokyo G.S.* **18** (1906): 165–176. **Tanaka.**

Lake Yamanaka. By Akamaro Tanaka. *With Sketch-maps, Illustrations, and Diagrams.* [In Japanese.]

Japan—Structure. *J. Tokyo G.S.* **18** (1906): 407–414. **Fukuchi.**

On the Fiji Volcanic Zone. By Nobuyo Fukuchi. [In Japanese.]

Japan—Volcanic Island. *J. Tōkyō G.S.* **17** (1905): 625–637, 702–727. **Satō.**

Geographical Trip to the New Sulphur Island. By Denzō Satō. *With Maps and Illustrations.* [In Japanese.]

Malay Archipelago—Sumatra. **Quast.**

Ts. Ind. Taal-, Land- en Volk. **48** (1906): 408–487.

Verslag nopens den politieken toestand in de Rokanstaatjes. Van H. C. E. Quast. *With Map.*

Russian Turkestan. *Abrégé B.S. Hongroise G.* **34** (1906): 96–105. **Prinz.**

Reiseskizzen aus Central-Asien. Von Dr. Julius Prinz. I. Aus Fergana in das Narin-Becken. (*Földrajzi Közlemények* **34** (1906): 215–224; *with sections.*)

Tibet.

Treaty Series; No. 9, 1906. Convention between the United Kingdom and China respecting Tibet. Signed at Peking, April 27, 1906. To which is annexed the Convention between the United Kingdom and Tibet, signed at Lhasa, September 7, 1904. London: Harrison & Sons, 1906. Size 9½ × 6, pp. 8. *Price* ½*d.*

See note in the November number (vol. **28**, p. 506).

Turkey—Arabia. *G.Z.* **12** (1906): 425–439. **Kleist.**

England in Arabia. Von Oberleutnant v. Kleist.

Turkey—Palestine. **Ewing.**

Arab and Druze at home: a record of travel and intercourse with the people east of the Jordan. By William Ewing. London: T. C. & E. C. Jack, 1907. Size 8 × 5½, pp. xii. and 180. *Map and Illustrations. Price* 5*s. net. Presented by the Publishers.*

Gives the results of familiar intercourse with the peoples both east and west of the Jordan during a residence of over five years in Palestine.

Turkey—Syria. **Bel.**

The Desert and the Sown. By Gertrude Lowthian Bell. London: W. Heinemann, 1907. Size 9 × 6, pp. xvi. and 348. *Map and Illustrations. Price* 16*s. net. Presented by the Publisher.* [Reviewed, *ante*, p. 445.]

Western Asia—Trade-routes. **Schlagintweit.**

Verkehrswege und Verkehrsprojekte in Vorderasien. Von Max Schlagintweit. (Schriften der Deutsch-Asiatischen Gesellschaft . . . 2 Heft.) Berlin: Hermann Paetel, 1906. Size 9 × 6, pp. 42. *Map. Price* 1*s.*

AFRICA.

Africa—British Colonies.

Colonial Reports, Annual, No. 500. The Surveys and Explorations of British Africa. The Annual Report of the Colonial Survey Committee. First Year: To August, 1906. London, 1906. Size 9½ × 6, pp. 52. *Maps and Illustrations. Price* 2*s.* 7*d.*

Africa—Zoology.

Correspondence relating to the Preservation of Wild Animals in Africa. London, 1906. Size 13 × 8½, pp. xxiv. and 392. *Maps. Price* 4*s.*

Central Africa. **Lemaire.**

Tra Mez-Afriko. (A travers l'Afrique centrale.) Par le Commdt. Ch. Lemaire. [In French and Esperanto.] Size 11 × 8½, pp. 86. *Map and Illustrations. Presented by the Author.*

An account of Major Lemaire's journey given before the Geneva Esperanto Congress in September, 1906.

Congo State *B.S.G. Italiana* **7** (1906): 963–978. **Cordella.**

Appunti sulla zona del Maniema (Riva sinistra del Lualaba), del capitano Ernesto Cordella.

Congo State. *Z. Ges. Erdk. Berlin* (1906): 426–431, 493–497. **Frobenius.**

Leo Frobenius' Forschungsreise in das Kassai-Gebiet. III. and IV. Bericht. Von L. Frobenius.

See *Journal*, **28**, 181 and 508.

Congo State.

État Independant du Congo. Annales du Musée du Congo. Ethnographie et Anthropologie.—Série III. Notes Analytiques sur les Collections Ethnographiques du Musée du Congo. Tome I.—Fasc. II. La Religion. Bruxelles: Spineux et Cie., 1906. Size 14½ × 12, pp. 145–316. *Plates.*

Egyptian Sudan. *B. Comité Afrique Française* **16** (1906): 189–194. **Mézières.**

Mission Bonnel de Mézières. Au Soudan Anglo-Égyptien. Par A. Bonnel de Mézières.

Report on the general position in the Sudan.

German East Africa. *Z. Kolonialpolitik, etc.* **8** (1906): 665–695. **Most.**

Die wirtschaftliche Entwickelung Deutsch-Ostafrikas, 1885–1905. Von Karl Most.

German East Africa. **Fülleborn.**

Das Deutsche Njassa- und Ruwuma-Gebiet, Land und Leute, nebst Bemerkungen über die Schire-Länder. Mit Benutzung von Ergebnissen der Njassa- und

Kingagebirge-Expedition der Hermann und Elise geb. Heckman Wentzel-Stiftung verfasst von Dr. Friedrich Fülleborn. (Deutsch-Ost-Africa, . . . Band IX.) Berlin: D. Reimer, 1906. Size 11 × 7½, pp. xx. and 636. *Illustrations, Maps and Plates in separate Atlas*, size 17 × 12. *Price (volume)* 60m., *and (Atlas)* 65m. *Presented by the Publisher.* [To be reviewed.]

German South-West Africa—Ethnology. **Bayer.**

Z. Kolonialpolitik, etc. **8** (1906): 625–648.

Die Nation der Bastards. Von Bayer. *With Map and Illustrations.*

German South-West Africa. *M. Deutsch. Schutzgebieten* **19** (1906): 257–273. **Schulze.**

Zwischen Lüderitzbucht und Kubub. Von Hauptmann Schulze. *With Maps and Illustrations.*

Gold Coast. **Crowther.**

Quarterly J.I. Com. Research Tropics, Liverpool University **1** (1906): 167–182.

Notes on a District of the Gold Coast. By F. Crowther. *With Maps.*

Ivory Coast. **Clozel.**

F.-J. Clozel. Dix ans à la Côte d'Ivoire. Paris: A. Challamel, 1906. Size 11½ × 7½, pp. 350. *Maps and Illustrations. Price* 12*s.* 6*d.* [To be reviewed.]

Morocco. *Renseignements Col., Comité Afrique Française* (1906): 227–234. **Buchet.**

Mission Buchet. Rapport sommaire d'ensemble. Par G. Buchet.

The author carried out trigonometrical surveys in North-West Morocco, besides making geological, zoological, ethnological, and other observations.

Morocco—Railways. *B.R.S.G. Madrid, Rev. G. Col.* **3** (1906): 399–408. **Faria.**

Futuros ferrocarriles de Marruecos. Por P. G. Faria.

Portuguese East Africa. **Cairncross.**

B.S.G. Lisboa **24** (1906): 22–30, 50–54, 88–91, 181–185.

A região de Manica. Por W. M. Cairncross; traduzido por João Farmhouse.

Portuguese East Africa. **Maugham.**

Portuguese East Africa. The History, Scenery, and Great Game of Manica and Sofala. By R. C. F. Maugham. London: John Murray, 1906. Size 9 × 6, pp. xii. and 340. *Map and Illustrations. Price* 15*s. net. Presented by the Publisher.*

See review in the February number (p. 216).

Portuguese East Africa. *B.S.G. Lisboa* **24** (1906): 111–128, 147–160. ———

Estatistica em paizes não civilisados. Territorio de Manica e Sofala.

Portuguese East Africa. ———

Guia Postal do Territorio de Manica e Sofala sob a Administração da Companhia de Moçambique. Beira, 1906. Size 8½ × 6, pp. viii. and 156. *Illustration. Presented by the Companhia de Moçambique.*

Portuguese East Africa. **Machado.**

B.S.G. Lisboa **24** (1906): 33–50, 65–87.

Arterias de Communicação nos districtos de Sofala e Manica. Por Carlos Roma Machado. *With Map.*

Rhodesia. **Randall-MacIver.**

Mediæval Rhodesia. By David Randall MacIver. London: Macmillan & Co., 1906. Size 11½ × 9, pp. xvi. and 106. *Illustrations. Price* 20*s. net. Presented by the Publishers.* [Reviewed July, 1906, p. 68.]

St. Helena. **Dehérain.**

La prise de possession de Sainte-Hélène par la Grande-Bretagne au XVII^e^ Siècle. Par H. Dehérain. Paris: Imp. Nationale, 1906. Size 11 × 9, pp. 16. *Presented by the Author.*

San Thomé. *B.S.G. Lisboa* **211** (1906): 97–110. **Strunk.**

Relatorio do Dr. Strunk sobre una viagem a S. Thomé. (Traduzido e communicado pelo Sr. Salema Barbosa.)

South Africa. **Handley.**

Briton, Boer, and Black; or, Ten Years' Hunting, Trading, and Prospecting in South Africa. By Clement Handley. London: T. Sealey Clark. 1906. Size 8½ × 5½, pp. xvi. and 342. *Illustrations. Price* 10*s.* 6*d. net. Presented by the Publisher.*

Gives some insight into life on the outskirts of civilization in South Africa. The author was farming in the Transvaal at the time of the Jameson raid, of which he gives some details from personal knowledge.

South Africa—Historical. *P. Rhodesia Sc. Ass.* **5** (1905): 40–54. **Torrend.**
The Sabæans on the Zambesi. By Rev. J. Torrend. *With Map.*

South Africa—Kalahari. *P. Rhodesia Sc. Ass.* **5** (1906): 29–40. **Wilson.**
The Northern Kalahari Desert. By W. Wilson.

West Africa—Boundary. *M. Deutschen Schutzgeb.* **19** (1906): 181–256. **Ambronn.**
Berichte über die astronomischen und geodätischen Aufnahmen, welche zum Zwecke der Grenzregulierung zwischen Kamerun und dem Congo-Français in den Jahren 1900 bis 1902 ausgeführt wurden. Bearbeitet mit Benutzung der Berichte des Expeditionsleiters Herrn Hauptmann Engelhardt von Prof. Dr. L. Ambronn. *With Maps.*

NORTH AMERICA.

Arizona and Mexico. *Science* **24** (1906): 116–118. **Merrill.**
Evidences of Glaciation in Southern Arizona and Northern Sonora. By Dr. F. J. Merrill.

Canada—Guide-book. **Baedeker.**
The Dominion of Canada, with Newfoundland and an expedition to Alaska. Handbook for travellers by Karl Baedeker. Third revised and augmented edition. London: Dulau & Co., 1907. Size 6½ × 4, pp. lxiv. and 332. *Maps and Plans. Price 6 marks. Presented by the Editor.*
The second edition was published in 1900, and the rapid development of Canada within the past half-dozen years renders the appearance of a third particularly welcome.

North America—Vegetation. **Wiesner.**
Sitzb. K.A.W. Wien **114** (Ab. I.) (1905): 77–150.
Untersuchungen über den Lichtgenuss der Pflanzen im Yellowstonegebiete und in anderen Gegenden Nordamerikas. Photometrische Untersuchungen auf pflanzenphysiologischem Gebiete (V. Abhandlung) von J. Wiesner.
See note in vol. **26**, p. 459.

United States—California. *Popular Sc. Monthly* **69** (1906): 69–75. **Ashley.**
The geological prelude to the San Francisco earthquake. By Geo. H. Ashley. *With Sketch-maps and Diagrams.*

United States—Cotton.
Cotton Production and Statistics of Cottonseed Products. 1905. (Dept. of Commerce and Labor. Bureau of the Census, Bulletin 40.) Washington, 1906. Size 11½ × 9, pp. 72. *Maps.*

United States—Earthquakes. *Popular Sc. Monthly* **69** (1906): 76–86. **Fuller.**
Our greatest earthquakes. By Myron Leslie Fuller. *With Illustrations.*

United States—Michigan. *J. Geology* **14** (1906): 411–424. **Goldthwait.**
Correlation of the raised beaches on the west side of Lake Michigan. By James Walter Goldthwait. *With Sketch-map, Profile, and Illustrations.*

United States—Mississippi. *Popular Sc. Monthly* **69** (1906): 248–256. **Brown.**
The Protection of the Alluvial Basin of the Mississippi. By Robert Marshall Brown. *With Sketch-maps and Profiles.*
Based largely on the reports of the Mississippi River Commission.

CENTRAL AND SOUTH AMERICA.

Paraguay. **Decoud**
Geografía de la República del Paraguay. Por Héctor F. Decoud. 5ª Edición. Leipzig, 1906. Size 8 × 6, pp. 128. *Map and Illustrations. Presented by the Consul-General for Paraguay.*

Paraguay. **Vallentin.**
Paraguay: das Land der Guaranís. Von Dr. Wilhelm Vallentin. Berlin: H. Paetel, 1907. Size 10 × 7, pp. viii. and 324. *Illustrations. Price 6s.*
Description of a journey in Paraguay, embodying a good deal of practical information on the present position of the country and its resources.

Peru—Minerals. *B. Cuerpo Ingen. Minas, Perú*, No. 35 (1906): pp. 120. **Dueñas.**
Recursos minerales de las provincias de Jauja y Huancayo. Por E. I. Dueñas. *With Map and Illustrations.*

Peru—Minerals. *B. Cuerpo Ingenieros Minas, Peru*, No. 29 (1905): pp. 100. **Fuchs.**
La Región Cuprífera de los Alrededores de Ica y Nazca. Por Federico G. Fuchs. *With Map and Sections.*

South America—German Colonies. *Z. Kolonialpolitik, etc.* **8** (1906): 436–440. **Klössel.**
Deutsche Kolonisation in Südamerika. Von M. Hans Klössel.

AUSTRALASIA AND PACIFIC ISLANDS.

Bismarck Archipelago. **Stephan.**
Südseekunst. Beiträge zur Kunst des Bismarck-Archipels und zur Urgeschichte der Kunst überhaupt. Herausgegeben von Dr. Emil Stephan. Berlin: Dietrich Reimer, 1907. Size 11 × 7, pp. 16* and 146. *Map and Illustrations. Price* 6*s.*

Bismarck Archipelago. **Stephan and Graebner.**
Neu-Mecklenburg (Bismarck-Archipel). Die Küste von Umuddu bis Kap St. George. Forschungsergebnisse bei den Vermessungsfahrten von S. M. S. Möwe im Jahre 1904. Herausgegeben von Dr. Emil Stephan und Dr. Fritz Graebner. Berlin: Dietrich Reimer, 1907. Size 11 × 7, pp. 12* and 242. *Map and Illustrations. Price* 12*s.*

These two works will be reviewed in a later number.

New Hebrides. **Bourge.**
Georges Bourge. Les Nouvelles Hébrides de 1606 à 1906. Paris: A. Challamel, 1906. Size 7½ × 5½, pp. 288. *Illustrations. Price* 3*s.* 9*d.*

A useful summary of our knowledge of the group, and of the history of European relations with it.

New Zealand—Botany. **Cockayne.**
Notes on the Subalpine Scrub of Mount Fyffe (Seaward Kaikouras). By L. Cockayne, PH.D. (From *Transactions of the New Zealand Institute*, vol. **38**, 1905.) Size 8½ × 5½, pp. 361–374.

New Zealand—Poor Knights Islands. **Cockayne.**
Notes on a brief botanical visit to the Poor Knights Islands. By L. Cockayne, PH.D. (From *Transactions of the New Zealand Institute*, vol. **38**, 1905.) Wellington, 1906. Size 8½ × 5½, pp. 351–360.

These two papers have been noticed in the Monthly Record (January, p. 92).

Pacific Islands. *Z. Ges. Erdk. Berlin* (1906): 323–346, 385–404. **Arldt.**
Parallelismus der Inselketten Ozeaniens. Von Dr. T. Arldt. *With Map.*

Noticed in the *Journal* for November, 1906 (p. 511).

Samoa—Tutuila. *J. of G.* **5** (1906): 18–26. **Kellogg.**
American Samoa. By Vernon L. Kellogg. *With Illustrations.*

South Australia. **George.**
South Australia. Report of Mr. F. R. George on his Prospecting Expedition North of Nullarbor Plains. Adelaide, 1905. Size 13½ × 8½, pp. 4. *Map.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Geophysics. *Science* **24** (1906): 301–303. **See.**
The Nature and Origin of Volcanic Heat. By Dr. T. J. J. See.

The writer believes in a fluid substratum beneath the solid crust, and that one common cause producing motion just at this depth underlies earthquakes, volcanoes, the formation of mountains, and other allied phenomena. He postpones, however, the development of his views to a future occasion.

Geophysics. *P.R.S., Ser. A.* **78** (1906): 150–153. **Strutt.**
On the Distribution of Radium in the Earth's Crust. Part ii. Sedimentary Rocks. By the Hon. R. J. Strutt.

Glaciology. *J. Geology* **14** (1906): 402–410. **Reid.**
The Variations of Glaciers. XI. By Harry Fielding Reid.

Summary of the tenth annual report of the International Committee.

Gravity. *Sitzb. K.A.W. Wien* **114** (Ab. IIa.) (1905): 695–710. **Spitaler.**
Periodische Verschiebungen des Schwerpunktes der Erde. Von Prof. Dr. R. Spitaler.

Hydrology. **Andrimont.**

La science hydrologique; ses méthodes, ses récents progrès, ses applications. Par René d'Andrimont. Paris, etc.: Ch. Béranger, 1906. Size 9 × 6, pp. 116. *Diagrams. Price* 4*s.*

A concise and useful summary of our knowledge of the circulation of water, both on land and in the ocean, and of modern methods of research on the subject.

Kumatology. *B. Musée Océanographique Monaco*, No. 57 (1906): pp. 18. **Berget.**

La houle et les vagues. Par A. Berget.

Limnology—Temperature. *Petermanns M.* **52** (1906): 184–186. **Aufsess.**

Eine photographische Methode zur Bestimmung des Eindringens der Wärmestrahlung in einer See. Von Dr. Otto Frhr. v.u.z. Aufsess. *With Illustrations.*

Meteorology. *Sitzb. K.A.W. Wien* **114** (Ab. IIa.) (1905): 1271–1292. **Exner.**

Ueber Druck und Temperatur bewegter Luft. Von Dr. F. M. Exner.

Meteorology. *Sitzb. K.A.W. Wien* (Ab. IIa.) (1905): 1519–1568. **Samec.**

Durchsichtigkeit der Luft bei verschiedenen Witterungszuständen in Wien. Von Dr. M. Samec. *With Diagrams.*

Meteorology—Dustfalls. *Beiträge Geophysik* **8** (1906): 7–42. **Krebs.**

Staubfälle, besonders im Passatgebiet des Nordatlantik. (Neue Folge.) Von W. Krebs.

Meteorology—Solar radiation. **Hopfner.**

Sitzb. K.A.W. Wien **114** (Ab. IIa.) (1905): 1315–1357.

Die Verteilung der solaren Wärmestrahlung auf der Erde. Von Dr. F. Hopfner.

Mathematical discussion of the latitudinal and seasonal distribution of solar heat on the Earth's surface.

Meteorology—Wind. **Simpson and others.**

The Beaufort Scale of Wind-force. Report of the Director of the Meteorological Office upon an Inquiry into the relation between the estimates of wind-force according to Admiral Beaufort's scale and the velocities recorded by Anemometers belonging to the office. With a Report upon certain points in connection with the Inquiry, by G. C. Simpson, M.Sc., and Notes by Sir G. H. Darwin, K.C.B., W. H. Dines, F.R.S., and Commander Campbell Hepworth, C.B. London: Wyman & Sons, 1906. Size 12 × 10, pp. 54. *Diagrams. Price* 1*s.* 6*d.*

Meteorology—Wind-transport. *Deutsch. Rundschau G.* **28** (1906): 442–447. **Krebs.**

Staub-, Vogel- und Insekten-Transporte durch Luftströmungen, besonders aus der westlichen Sahara. Von W. Krebs. *With Map.*

Ocean and Climate. *J. of Geology* **14** (1906): 363–373. **Chamberlin.**

On a possible reversal of deep-sea circulation and its influence on geologic climates. By T. C. Chamberlin.

Oceanography—Atlantic. *B.R.S.G. Madrid, Rev. G. Col.* **3** (1906): 384–390. **Vera.**

Formación de tierras en el seno de las aguas. Nuevas islas Canarias saliendo del fondo del Atlántico. Por V. Vera.

Oceanography—Museum. *Z. Ges. Erdk. Berlin* (1906): 257–266. **Dinse.**

Das neue Museum für Meereskunde in Berlin. Von Dr. P. Dinse.

Oceanography—North Sea. *Z. Ges. Erdk. Berlin* (1906): 482–489. **Brühl.**

Die zweite Studienfahrt des Instituts für Meereskunde zu Berlin. Von Dr. L. Brühl.

Phytogeography—Algæ. **Mangin.**

B. Musée Océanographique Monaco, No. 82 (1906): pp. 34.

Distribution des Algues: algues fixées, algues du Plankton. Par L. Mangin. *With Charts and Illustrations.*

Seismology. *Sitzb. K.A.W. Wien* **114** (Ab. IIa.) (1905): 1407–1430. **Benndorf.**

Ueber die Art der Fortpflanzung der Erdbebenwellen im Erdinnern. Von Dr. H. Benndorf.

Seismology. *Abrégé B.S. Hongroise G.* **34** (1906): 26–34. **Pécsi.**

Grundzüge der geometrischen Theorie der Erdbeben. Von Dr. Albert Pécsi. (*Földrajzi Közlemények* **34** (1906): 53–62, *with Diagrams.*)

Volcanoes. *Popular Sc. Monthly* **68** (1906): 453–550. **Dutton.**

Volcanoes and Radioactivity. By Major C. E. Dutton.

Volcanoes. *Petermanns M.* **52** (1906): 165–167. **Krebs and Sapper.**

Ueber Beziehungen des Meeres zum Vulkanismus. Von W. Krebs und Prof. Dr. K. Sapper.

Zoogeography—Fishes. **Strodtmann.**

Arbeiten der Deutschen wissenschaftlichen Kommission für die internationale Meeresforschung. B. Aus der Biologischen Anstalt auf Helgoland. No. 4. Laichen und Wandern der Ostseefische. II. Bericht. Von S. Strodtmann. Oldenburg i Gr., 1906. Size 13 × 11, pp. 137–216. *Map. Presented by the Commission.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography. **Schlüter.**

Die Ziele der Geographie des Menschen. Von Otto Schlüter. München, etc.: R. Oldenburg, 1906. Size 8½ × 5½, pp. 64. *Price* 1.20*m. Presented by the Publisher.*

Anthropology. **[Kingsford.]**

Anthropological Photographs. Report of the Committee . . . appointed for the Collection, Preservation, and Systematic Registration of Photographs of Anthropological Interest. (Drawn up by the Secretary.) [British Association, Section H; York, 1906.] Size 8½ × 5½, pp. 18.

Contains a first list of photographs registered.

Colonisation. *J. of G.* **5** (1906): 11–17. **Hubbard.**

The Industrial and Commercial Importance of a Tropical Possession. By George D. Hubbard.

Commercial—Cocoa. *Ann. G.* **15** (1906): 289–298. **Chevalier.**

Le cacao. Sa production et sa consommation dans le monde. Par A. Chevalier.

Commercial—Petroleum. **Redwood.**

Petroleum: a Treatise on the Geographical Distribution and Geological Occurrence of Petroleum and Natural Gas; the Physical and Chemical Properties, Production, and Refining of Petroleum and Ozokerite, the Characters and Uses, Testing, Transport, and Storage of Petroleum Products, and the Legislative Enactments relating thereto: together with a Description of the Shale Oil and allied Industries; and a full Bibliography. By Sir Boverton Redwood. Second Edition. 2 vols. London: Charles Griffin & Co., Ltd., 1906. Size 9 × 6, pp. xxxii. and 1064. *Maps and Illustrations. Price* 45*s. net. Presented by the Publishers.* [To be reviewed.]

Historical. **Blázquez.**

Antonio Blázquez. Los Manuscritos de los Comentarios al Apocalipsis de San Juan por San Beato de Liébana. (De la Revista de Archivos, Bibliotecas y Museos.) Madrid, 1906. Size 10 × 7, pp. 18. *Facsimile Map. Presented by the Author.*

On the MSS. (twenty-five in all) of the work containing the famous "Beatus" map, which, as shown by K. Miller, was the type of a whole group of early maps.

Historical—Columbus. **Young.**

Christopher Columbus and the New World of his discovery. A narrative by Filson Young, with a note on the navigation of Columbus's first voyage by the Earl of Dunraven. 2 vols. London: E. Grant Richards, 1906. Size 9 × 6, pp. (vol. 1) xxii. 324; (vol. 2) x. 400. *Maps and Illustrations. Price* 25*s. net.*

This makes no claim to be the result of original research, but aims at gathering up, for the benefit of the general public, the results of the studies of experts on Columbus and his work, which have appeared within recent years. In the case of points still under dispute, *e.g.* the question of the forgery of the Toscanelli correspondence, no great attempt is made to sift the evidence from an independent standpoint.

Historical—Exploration. **Williams.**

The Romance of Early Exploration; with descriptions of Interesting Discoveries, Thrilling Adventures, and Wonderful Bravery of the Early Explorers. By Archibald Williams. London: Seeley & Co., 1907 [1906]. Size 8 × 5, pp. 346. *Sketch-maps and Illustrations. Price* 5*s. Presented by the Publishers.*

Brings out, as is indicated by the title, the side of early travel which specially

appeals to the imagination. The facts appear, however, to have been collected with care.

Historical—Ophir. *Asiatic Quarterly Rev.* **22** (1906): 118-130. **McNair.**
Ophir. By J. F. A. McNair.
The author is inclined to put the gold region in the Malay peninsula.

Historical Geography. *J. Manchester G.S.* **22** (1906): 56-64. **Dunn.**
Orography and History. By E. W. Dunn.

History of Geography. *G.Z.* **12** (1906): 440–449. **Berger.**
Die ältere Zonenlehre der Griechen. Von Hugo Berger.

Military Geography. *J.R. Artillery* **33** (1906): 229–252. **May.**
Geography in relation to War. By Colonel E. S. May, C.B., etc. *With Sketch-maps.*

Sociology—Jews. *Popular Sc. Monthly* **69** (1906): 257–267. **Fishberg.**
The Jews: a Study of Race and Environment. By Maurice Fishberg.

BIOGRAPHY.

Rennell. **Frenzel.**
Major James Rennell, der Schöpfer der neueren Englischen Geographie. Ein Beitrag zur Geschichte der Erdkunde. Inaugural-Dissertation . . . von Curt Arthur Frenzel. Pulsnitz, 1904. Size 8½ × 5½, pp. viii. and 196. *Portrait. Presented by the Author.*
A careful and complete account of the geographical work of Rennell.

GENERAL.

British Colonies. **Lucas.**
A Historical Geography of the British Colonies. By C. P. Lucas. Vol. 1: The Mediterranean and Eastern Colonies. Second Edition, revised and brought up to date by R. E. Stubbs. Oxford: Clarendon Press, 1906. Size 7½ × 5, pp. viii. and 304. *Maps. Price* 5*s. net.*
This volume has been subjected to a very thorough revision, the editor having been aided throughout by local experts of the Colonial Service.

Educational. **Morgan.**
The Practical Teaching of Geography in Schools and Colleges. By Dr. Alex. Morgan. Fourth Edition. London: G. Philip & Son, 1906. Size 9¼ × 6¼, pp. 18. *Diagrams. Price* 6*d. net. Presented by the Publishers.*

Educational—Methods. *J.G.* **5** (1906): 97–108. **Goode.**
Laboratory Work with the Sun. By J. Paul Goode. *With Diagrams.*
Describes methods of solving problems by the help of an instrument designed by the writer, and called by him a "Sun-board."

Geography. *J. of G.* **5** (1906): 1–10. **Brown.**
Geographical Changeableness. Some Characteristics and Values. By Robert Marshall Brown.
Urges the need of modifying geographical conceptions with the advance of knowledge.

Marseilles Geographical Society. **Léotard and Guillaumet.**
B.S.G. Marseille **30** (1906): 1–112.
Histoire de la Société (1786–1906. Par J. Léotard.—Table Générale des Matières du Bulletin (1877–1905). Par J. Léotard, et A. Guillaumet. *With Illustrations.*

Travel. **Jerningham.**
From East to West. Notes by the way. By Sir Hubert Jerningham, K.C.M.G. London: J. Murray, 1907. Size 9 × 6, pp. xiv. and 352. *Maps and Illustrations. Price* 15*s. net. Presented by the Publisher.*
Narrative of a voyage to Japan, to which country the bulk of the work is devoted (see note on p. 454, *ante*).

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

Belgium. **Institut Cartographique Militaire.**

Carte de la Flandre Occidentale, 1906. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. 4 sheets. Brussels: Institut Cartographique Militaire, 1906.

A useful general map of the country between Ostend and Bruges and the districts to the south as far as Lille. It is printed in colours, and special attention has been given to canals, roads, and railways.

British Isles. **Bartholomew.**

Bartholomew's contour motoring map of the British Isles, showing the best touring roads with heights and distances. Reduced by permission from the Ordnance Survey. Scale 1 : 1,000,000 or 1 inch to 15·8 stat. miles. Edinburgh: John Bartholomew & Co., [1907]. *Price 5s. net. Presented by the Publisher.*

On this map land under 250 feet in altitude is uncoloured, after which the relief is indicated by four tints of brown, ranging as follows: 250 to 500, 500 to 1000, 1000 to 2000, and above 2000 feet. In addition to the tinting, heights of important points are given in figures. Roads are shown in red, and other information specially valuable to motorists, such as places with garages, hotels, etc., are given by symbols. Figures in red indicate distances between places which are marked by black dots. There are inset plans, on enlarged scales, of the environs of London, Manchester, Glasgow, and Dublin, as well as useful tables of distances.

England and Wales. **Ordnance Survey.**

Sheets published by the Director-General of the Ordnance Survey, Southampton, from February 1 to 28, 1907.

1 inch—(third edition):—

In outline, sheets 247, 279, 280. 1*s. each* (engraved).
With hills in brown or black, 71, 73, 121, 138. 1*s. each* (engraved).

6-inch—County Maps (first revision):—

Carmarthenshire, 23 N.E. **Devonshire,** 39 S.W., 51 S.W., 62 N.W., 74 N.E., S.E., 75 N.E., 88 S.W., 105 N.W., N.E., S.E., 112 S.W., 120 N.W., 131 S.W., 132 N.E., S.E., 133 N.E., S.W., 134 N.W. **Lincolnshire,** 43 N.E., S.E., 44 N.W., 51 S.E., 52 N.W., S.E., 53 N.W., S.W., S.E., 54 N.W., S.E., 55 S.E., 56 N.E., 57 N.E., S.E., 60 N.E., 62 S.W., 63 S.E., 64 S.W., S.E., 65 N.W., N.E., S.W., 66 N.W., N.E., S.W., 67 S.W., 73 S.E., 74 S.E., 75 S.W., 88 S.W. **Norfolk,** 7 S.W., S.E., 11 N.W., 17 N.E., 18 S.W., 22 S.W., 24 S.E., 25 S.E., 30 N.W., 36 S.W., S.E., 40 N.E., 41 N.W., 48 N.W., 49 N.E., 60 S.E., 61 S.W., 85 N.W., N.E., S.E., 91 S.E., 101 N.E. **Pembrokeshire** (1 S.W. and 2 N.W.), (1 S.E. and 2 N.E.), (2 N.W. and 1 S.W.). (2 N.E. and 1 S.E.), 3 S.W., 7 N.W. **Suffolk,** 5 S.E., 11 N.W., N.E., S.W., 20 N.W., S.W., S.E., 31 N.E., S.E., 32 S.W., 42 N.E., S.E., 43 S.W., 52 N.E., S.W., S.E., 53 N.W., S.W., 61 N.W., S.W., 70 N.W., 79 N.W. **Yorkshire** (First Revision of 1891 Survey), 272 S.W., 273 S.E., 274 N.E., 275 N.E., S.W., 276 N.W. 1*s. each.*

25-inch—County Maps (first revision):—

Carmarthenshire, XXI. 12, 14, 15, 16; XXVIII. 3, 4, 12, 16; XXIX. 1, 4, 5, 6, 8, 9, 13; XXXVI. 4; XXXVII. 1, 6, 7, 10, 11, 12, 15; XLIV. 3; LI. 2, 6; LIII. 16; LIV. 15; LVII. 4, 8; LVIII. 7, 10, 11; LIX. 1, 5, 9, 13. 3*s. each.* XX. 16. 1*s.* 6*d.* **Cornwall,** VII. 12, 16; X. 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 16; (XIII. 4 and XIV. 1), (XIII. 8 and XIV. 5), XIII. 12 (14, 15, 16); (XIII*a*. 16 and XVIII. 3, 4); (XIV. 1 and XIII. 4), (XIV. 5 and XIII. 8); (XVIII. 3, 4, and XIII*a*. 16), XVIII. (7 and 8), XVIII. 11, 12, 13, 14; XXVIII. 13, 14; XXIX. 14; XXXV. 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16; XXXVI. 1, 2, 3, 5, 7, 10, 11, 13, 14, 15; XLIII. 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16; XLIV. 1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 16; LV. 10, 14. **Devonshire,** CXVII. 14, 15; CXXIII. 3, 4, 8, 11, 12; CXXIV. 1, 5, 9, 13. **Kent** (Second Revision), XXXVII. 15; XLVIII. 2, 3, 6, 7, 8, 10, 11, 12, 14, 15; LVIII. 2. 3*s. each.* **Lancashire** (First Revision of 1891 Survey), CXI. 4. **Lincolnshire** (First Revision), XXIV. 11, 12, 16; XXV. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XXVI. 3, 6, 7, 11, 15, 16; XXVII. 8, 9; XXVIII. 2, 3, 4, 5, 10,

16; XXIX. 8, 9, 12, 13, 16; XXX. 3, 12, 13, 14; XXXV. 1; XL. 10. 3*s. each.* XXIV. 4, 7. 1*s.* 6*d. each.* **Norfolk**, LXV. 6, 10, 11; LXXV. 9, 10; LXXVII. 3; LXXXIX. 5, 6; **Pembrokeshire**, VII. 9, 10, 13, 14; XI. 12, 16; XII. 1, 2, 5, 6, 9, 10, 11, 12, 13, 14, 15; XVIII. 1, 2, 3, 4; XIX. 1, 2, 3, 5. 3*s. each.* XII. 16. 1*s.* 6*d.* **Yorkshire** (First Revision of 1891 Survey), CCXXII. 10, 14; CCXXXVII. 2, 3, 5, 6, 7, 8, 10, 11, 12, 14, 15; CCXXXVIII. 1, 2, 5, 9, 10, 11, 12, 14, 15; CCXLVIII. 3, 7, 8, 9, 10, 13, 16.

(*E. Stanford, London Agent.*)

England and Wales. **Geological Survey.**

1-inch—New Series. Colour printed. Newquay (Drift edition), 346; Falmouth and Truro, 352. 1*s.* 6*d. each.*

6-inch—Uncoloured. Glamorgan, 17 N.W., N.E., S.W., 35 S.W. 1*s.* 6*d. each.*

(*E. Stanford, London Agent.*)

England—Berkshire. **Ordnance Survey.**

Berkshire, showing schools. Prepared for the County Education Committee. Scale 1:63,360 or 1 inch to 1 stat. mile. 2 sheets. Southampton: Ordnance Survey Office, 1906. *Presented by the Berkshire Education Committee.*

Consists of the uncoloured one-inch Ordnance Survey sheets of Berkshire, joined as one map, with special information added concerning schools. By different symbols in red are indicated voluntary schools, council schools, disused schools, elementary schools receiving no grants, secondary schools, and voluntary schools transferred to the council. The boundaries of the county and parishes are shown by red lines.

Germany. **Höck.**

Versuch einer pflanzengeographischen Einteilung und Umgrenzung Norddeutschlands. Scale 1:3,700,000 or 1 inch to 58·4 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1907, Tafel 2. Gotha: Justus Perthes, 1907. *Presented by the Publisher.*

Germany. **K. Preussische Landesaufnahme.**

Karte des Deutschen Reiches. Herausgegeben von der Kartographischen Abteilungen der Königlichen Preussische Landesaufnahme. Scale 1:100,000 or 1 inch to 1·6 stat. mile. Sheets (coloured) 293, Potsdam; 296, Frankfurt-a-O. Berlin: K. Preussische Landesaufnahme, 1906. *Price* 1.50*m. each sheet.*

Norway. **Norges Geografiske Opmaaling.**

Generalkarte over det sydlige Norge. Scale 1:400,000 or 1 inch to 6·3 stat. miles. Sheet XV. *Price* 0.60 *kr. each sheet.* Topografisk kart over Kongeriget Norge. Scale 1:100,000 or 1 inch to 1·6 stat. mile. Sheets: 10 C, Sarpsborg; 25 D, Lillehammer; 31 B, Gausdal; 38 D, Nordre Fæmund; 46 D, Trondhjem; K 11, Steigen; K 12, Kjerringö; K 13, Bodö; M 9, Ofoten; V 1, Hjelmsö; V 8, Noarvas; V 9, Njullas; W 8, Hugstfjeld; Y 3, Vestertana; Æ 3, Baasfjord. *Price* 0.60 *kr. each sheet.* Christiania: Norges Geografiske Opmaaling, 1906. *Presented by the Norwegian Geographical Institute.*

Turkey. **Topographical Section, General Staff.**

Map of Turkey. Scale 1:250,000 or 1 inch to 3·9 stat. miles. Sheet, Adrianople. London: Topographical Section, General Staff, War Office, 1906. *Price* 2*s.* 6*d. net. Presented by the Director of Military Operations.*

AFRICA.

Egypt. **Egyptian Survey Department.**

Topographical Map of Egypt. Scale 1:50,000 or 1·6 inch to 1 stat. mile. Sheets: S.E. XIX.-VI. and VII.; XXI.-VIII. Giza: Survey Department, 1906. *Presented by the Director-General, Egyptian Survey Department.*

The first of these sheets includes the area extending from 26° to 26° 30′ N. lat., and 32° 30′ to 32° 40′ E. long., and the second that from 25° 50′ to 26° N. lat., and 32° 45′ to 33° E. long.

Gambia. **Topographical Section, General Staff.**

Gambia, reproduced from the work of the Anglo-French Boundary Commission, 1904–1905. Scale 1:250,000 or 1 inch to 3·9 stat. miles. Compiled in the

Topographical Section, General Staff. 2 Sheets. London: Topographical Section, General Staff, War Office, 1906.

The basis of this map is the extensive plane-table surveys of Major E. L. Cowie, the Chief British Commissioner for the boundary, and his assistant, Mr. A. B. B. de Tscharner, which has been adjusted by astronomical determinations.

German East Africa. **Sprigade and Moisel.**

Karte von Deutsch-Ostafrika. Begonnen unter Leitung von Dr. Richard Kiepert, fortgesetzt unter Leitung von Paul Sprigade und Max Moisel. Scale 1 : 300,000 or 1 inch to 4·7 stat. miles. Sheets: E 2, Bismarckburg; F 2, Kalambo-Mundung; F 3, Neu-Langenburg. Berlin: Dietrich Reimer (Ernst Vohsen), 1906. *Presented by Herr Max Moisel.*

These are important sheets including the country adjacent to the Anglo-German boundary between Lakes Nyasa and Tanganyika.

Kamerun. **"Petermanns Mitteilungen."**

Die Entwickelung der Nordgrenze von Kamerun. Scale 1 : 6,000,000 or 1 inch to 94·7 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1907, Tafel 3. Gotha: Justus Perthes, 1907. *Presented by the Publisher.*

Senegal. **Service Géographique de l'Afrique Occidentale Française.**

Carte de Sénégal. Levé par les Officiers du Service Géographique de l'Afrique Occidentale Française. Scale 100,000 or 1 inch to 1·6 stat. mile. Sheets: 3, N'Diago; 4, Ross; 7, St. Louis. Paris: Service Géographique de l'Armée, [1906]. *Price 2 fr. each sheet.*

Three sheets of a large-scale map of Senegal, the first issue of which appeared two years ago. Relief is shown by brown contour-lines at intervals of 10 metres, and by a judicious selection of symbols and tints a large amount of information is given concerning roads, paths, watercourses, lakes, forests, and other matter. No soundings are given round the coast, nor are the depths of rivers indicated in any manner.

AMERICA.

California. **Erdmann.**

Saltonsee, Californien, Oktober, 1906. Von H. Erdmann. Scale 1 : 1,200,000 or 1 inch to 18·9 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1907, Tafel 4. Gotha: Justus Perthes, 1907. *Presented by the Publisher.*

Canada. **Department of Militia and Defence, Ottawa.**

Topographic map of Canada. Scale 1 : 63,360 or 1 inch to a stat. mile. Ontario. Sheets 1 N.E. and 1 N.W., Guelph; 3, Niagara. London: Topographical Section, General Staff, War Office. Ottawa: Intelligence Branch, Department of Militia and Defence, 1906. *Presented by the Department of Militia and Defence, Ottawa.*

These are the first sheets of topographical maps of Canada which are now in course of preparation by the Surveys Division of the Department of Militia and Defence; they promise to fill a long-felt need, not only from a military point of view, but as supplying a good general map of the country. When an Intelligence Branch, under imperial officers, was organized in the above department, the want of any topographical map of the country was at once noted as a serious defect, and steps were promptly taken to secure the necessary surveys on which such maps could be based. The work was begun by Major-General Lake sending out, during the summer holidays, survey parties of cadets from the Royal Military College under the imperial officer on duty at the College, but it was afterwards found more satisfactory to transfer the surveying to a permanent staff, General Lake being assisted in the work by Captain A. Clyde Caldwell, R.C.E., Assistant-Director of Intelligence, and Captain W. B. Anderson, R.C.E., Assistant-Director of Surveys.

Elaborate and exact trigonometrical surveys take a long time to execute and are very costly, so rather than delay the matter, as the object was to produce, as rapidly as possible, reasonably reliable military maps, a more expeditious system of surveying was decided upon, giving a resulting accuracy sufficient for the purpose. This consisted in running a series of theodolite traverses some 15 miles apart, and adjusted upon triangulation points of the U.S. Lake Survey and the U.S. Coast and Geodetic Survey. To these traverses the topographical detail has been adjusted, the latter being in the first place filled in by prismatic compass, but now entirely by plane-table surveys, on the scale of 2 inches to a mile. The contours, which on the sheets are at 25-feet intervals, depend upon lines of spirit-levels run about 5 miles apart and referred to the datum of the U.S. Coast and Geodetic Survey. These are supplemented by levels run with Abney levels and aneroid readings. As a check upon the foundation work of

the map, and to ensure greater accuracy, a topographic triangulation has recently been commenced.

Since 1904 a sum of about $20,000 has been expended annually on the work, and about 6200 square miles of topography have been completed, including the Niagara peninsula, from Hamilton to Port Dover, with the greater portion of Eastern Ontario, a triangle with Ottawa, Gananoque, and Cornwall at its extremities. This triangle is now being extended to embrace another triangle having its apex at Montreal. The sheets, which are on the polyconic projection, are now creditably produced and printed in colours—water, blue; contours, brown; wooded land, green. Very complete information is given, by a careful selection of symbols, concerning means of communication, important buildings, and many other matters. Each sheet measures 25 × 18 inches.

It is sincerely to be hoped that they will be issued regularly, and as rapidly as possible.

South America. **Jannasch.**

Spezialkarte von Santa Catharina, Rio Grande do Sul, und Uruguay. Nach den neuesten quellen bearbeitet, herausgegeben von Dr. R. Jannasch. Ausgabe 1907. Scale 1:1,000,000 or 1 inch to 15·8 stat. miles. Berlin: Leopold Kraatz, 1907.

A general map of Brazil, south of lat. 26° S., including also the Republic of Uruguay and the adjacent parts of Argentina and Paraguay. It is well drawn and artistically printed in colours, but as a great deal of the cartographical material from which the map has been compiled is necessarily of an extremely approximate and sketchy nature, too much reliance must not be placed upon information concerning the interior districts, where, except in the immediate neighbourhood of railway lines and certain special districts, no exact surveys exist. The location of minerals is indicated, and the German and Italian colonies distinguished by different symbols.

South America. **Lange.**

Map of the River Pilcomayo from parallel 22° S. to the River Paraguay. By Gunnar Lange, M.AM.SOC.C.E. Scale 1:100,000 or 1 inch to 1·6 stat. mile. 7 sheets. Buenos Aires, 1906. *Presented by the Author.*

The map will be specially noticed.

GENERAL.

German Colonies. **Kolonial-Wirtschaftliche Komitee.**

Wirtschafts-Atlas der deutschen Kolonien. Herausgegeben von dem Kolonial-Wirtschaftlichen Komitee E. V. wirtschaftlichen Ausschuss der deutschen Kolonialgesellschaft. Berlin, [1907].

An atlas of the German colonial possessions, showing, by various symbols and colours, the distribution of vegetable products, location of minerals, railways, steamship lines, telegraphs, and other information connected with commercial geography. There are altogether ten sheets of maps, seven of which are devoted to Africa. The maps are preceded by ten pages of letterpress, including an account of the work of the Kolonial-Wirtschaftlichen Komitee, 1896–1906, and tables of exports and imports.

World. **Harmsworth.**

Harmsworth Atlas and Gazetteer. 500 maps and diagrams and 105,000 references. Part 9. London: The Amalgamated Press, Limited, 1907. *Price 7d. each part.*

This part contains the following maps: 115–116, North-West India; 145–146, South Africa (Industries and Communications); 169–170, North-East United States.

World. **Stieler.**

Neunten, von Grund aus neubearbeiteten und neugestochenen Auflage von Stielers Hand-Atlas, 100 Karten auf 200 Seiten mit 162 Nebenkarten in Kupferstich und einem alphabetischen Verzeichnis aller im Atlas verkommenden Namen (ungefähr 240,000 Namen enthaltend) herausgegeben von Justus Perthes' Geographischer Anstalt in Gotha. Lieferungen 39, 40, 41, and 42. Gotha: Justus Perthes, 1907. *Price 60 pf. each part.*

The following are the contents of these parts:—Lieferung 39 and 40 (in one). Bl. 35, Pyrenäische Halbinsel in 4 Blättern, Bl. 4; 83, West Canada; 93, West Indien; 96, Süd Amerika, in 6 Blättern, Bl. 2.—Lieferung, 41 and 42 (in one). Bl. 29, Frankreich, in 4 Blättern, Bl. 3; 53, Balkan Halbinsel in 4 Blättern, Bl. 3; 70, Afrika in 7 Blättern, Bl. 2, Ost Sahara. In addition to these maps, the last part contains a continuation of the Index to place-names.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during January, 1907. *Presented by the Hydrographer, Admiralty.*

New Charts.

No.	Inches.	
3643 m	= 10·5	Ports in the Shetland islands:—Balta harbour. 2*s.*
3600 m	= 1·9, 3·9, 5·9	Japan. Anchorages in Yezo island:—Yesashi anchorage, Abashari anchorage, Nemoro anchorage 2*s.*

New Plans and Plans added.

No.	Inches.	
1381 m	= 1·28	Africa, north coast, Bizerta lakes. Plan added:—Lake Bizerta. 2*s.*

Charts Cancelled.

No.		Cancelled by	No.
991	Anchorages on the coasts of Yezo island. Plan of Nemoro anchorage on this sheet.	Plan of Nemoro anchorage on new chart	3600

Charts that have received Important Corrections.

Index charts:—A to V. No. 2151, River Thames:—Broadness to Mucking light. 2298, Gulf of Bothnia (sheet 3):—Nystad light to Stor fiord. 2300, Gulf of Bothnia (sheet 5):—Stiernö point to Fiärderäg. 1073, France, north coast:—Dieppe. 909, North American lakes:—Mildrum point to St. Joseph island. 373, Plans in the Gulf of Mexico. 2458, Alaska:—Port Simpson to Cross sound. 3569, Alaska:—Port Valdez. 643, Africa, south coast:—Port Natal. 1000, Siam:—Pulo Condore group. 1342, Cochin China:—Fan Rang bay to Tongking gulf. 1602, China, east coast:—Approaches to the Yang-tse-kiang. 3585, China, east coast:—Approaches to the Wusung river. 3274, Yang-tse-kiang:—Tung Ting lake and Siang river. 1256, China, north coast:—Gulfs of Pe Chili and Liau Tung. 2405, Russian Tartary:—Kuril islands to Kamchatka. 691, Australia, east coast:—Normandy sound and Prince of Wales channel.

(*J. D. Potter, Agent.*)

Indian Ocean and Red Sea. **Meteorological Office.**

Meteorological Chart of the Indian Ocean north of 15° S. lat. and Red Sea for March, 1907. London: Meteorological Office, 1907. *Price* 6*d. each. Presented by the Meteorological Office.*

North Atlantic and Mediterranean. **Meteorological Office.**

Meteorological Chart of the North Atlantic and Mediterranean for March, 1907. London: Meteorological Office, 1907. *Price* 6*d. each. Presented by the Meteorological Office.*

North Atlantic. **U.S. Hydrographic Office.**

Pilot Chart of the North Atlantic Ocean for February, 1907. Washington: U.S. Hydrographic Office, 1907. *Presented by the U.S. Hydrographic Office.*

North Pacific. **U.S. Hydrographic Office.**

Pilot Chart of the North Pacific Ocean for March, 1907. Washington: U.S. Hydrographic Office, 1907. *Presented by the U.S. Hydrographic Office.*

Norway. **Norges Geographiske Opmaaling.**

Specialkarte over den norske kyst. Scale 1 : 25,000 or 2·5 inches to a stat. mile. Sheets C 1, 2, and 3. Specialkarte over den norske kyst. Scale 1 : 50,000 or 1·3 inch to a stat. mile. Sheets B 45', 50, 53, 65, 66, 68. Specialkarte over Havne i Finmarken. Scale 1 : 50,000 or 1·3 inch to a stat. mile. Sheet ii. Christiania: Norges Geografiske Opmaaling, 1907. *Presented by the Norwegian Geographical Institute.*

PHOTOGRAPHS.

Mongolia. **Hedley.**

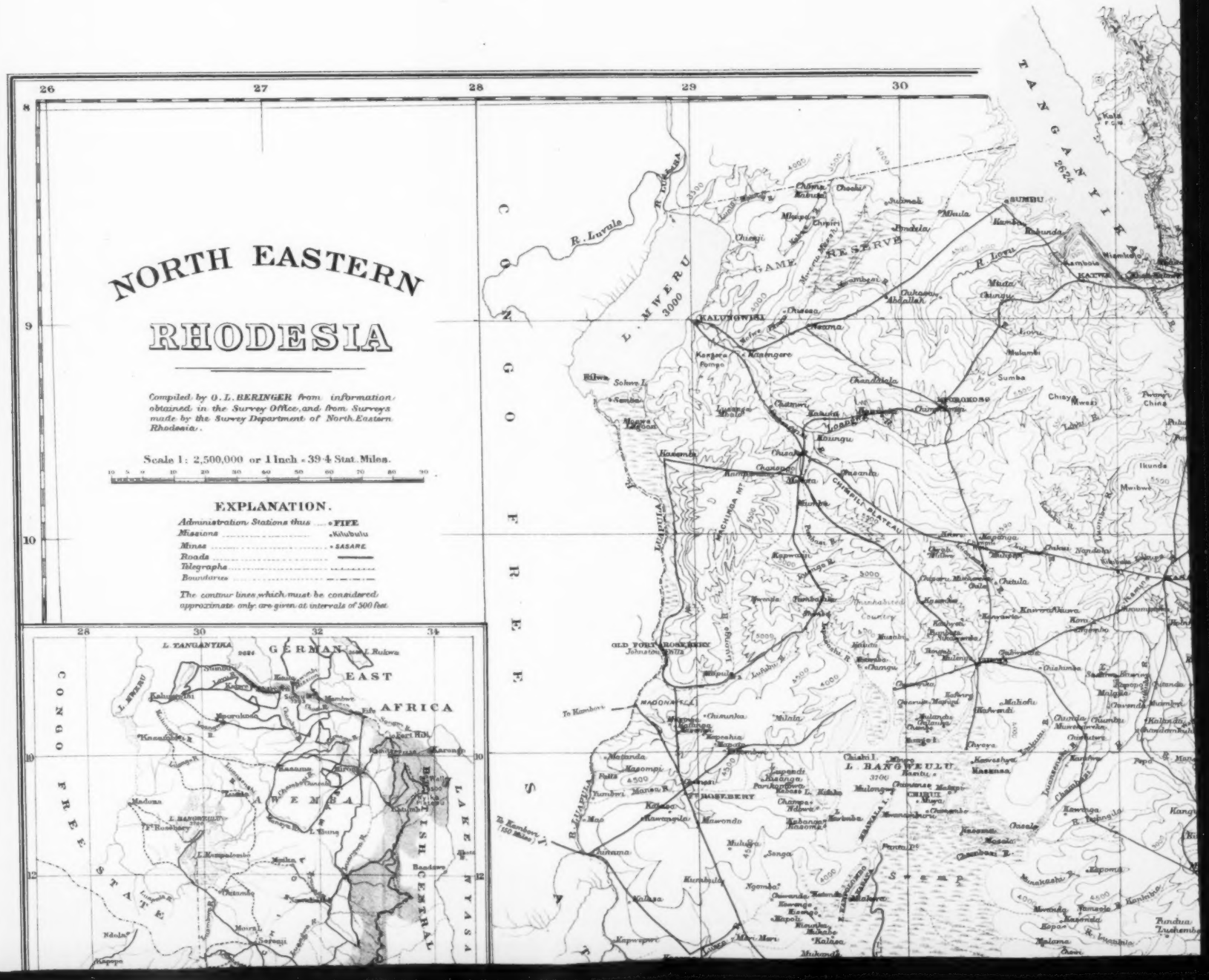
One hundred and fifteen photographs of Inner Mongolia or Outer Chih-li, taken by the Rev. John Hedley. *Presented by the Rev. John Hedley.*

These photographs were taken during an interesting journey made last year by

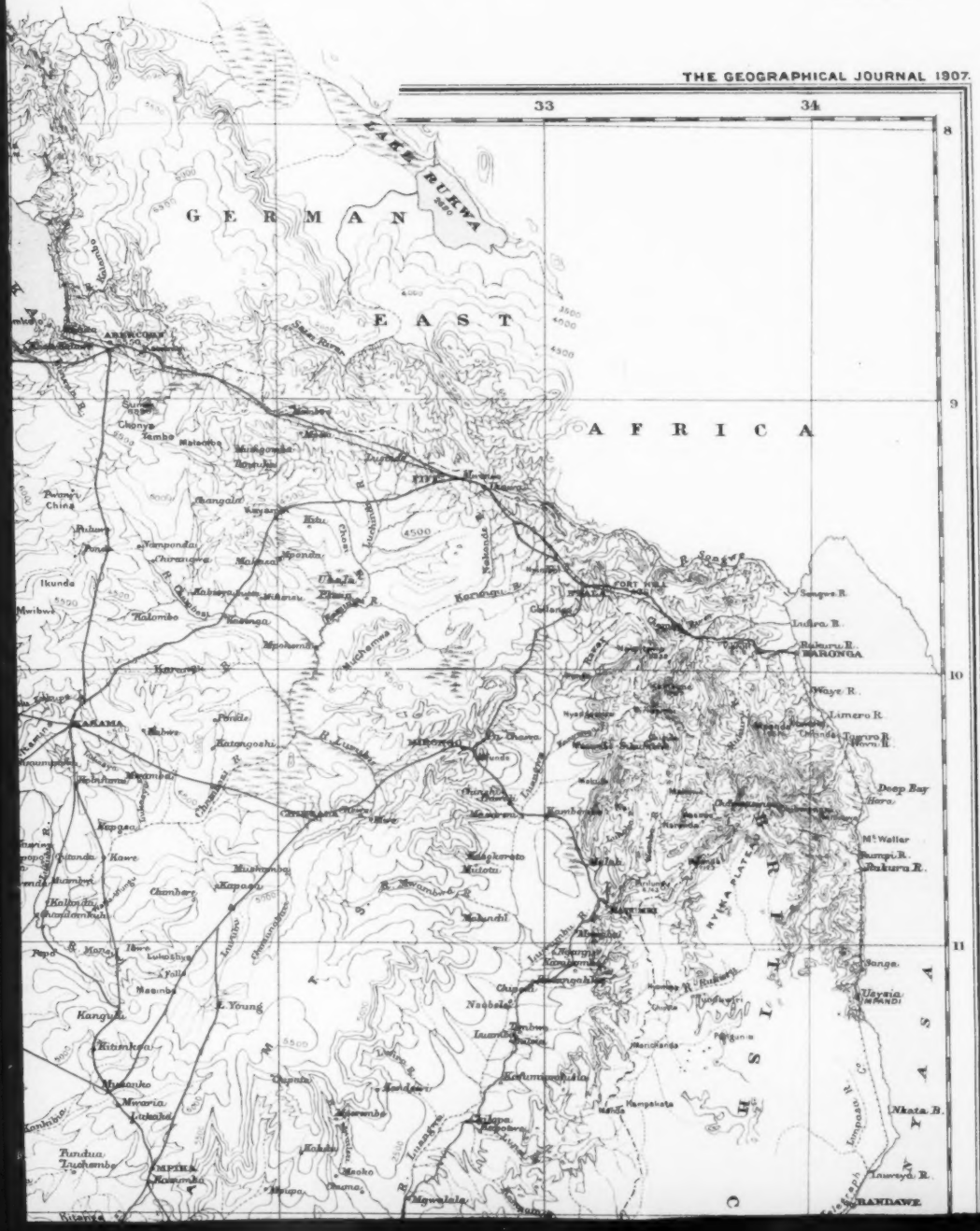
Mr. Hedley, and concerning which a short account, with a sketch-map, will shortly appear in the *Geographical Journal*. Although small, many of them are remarkably clear. The following are the titles:—

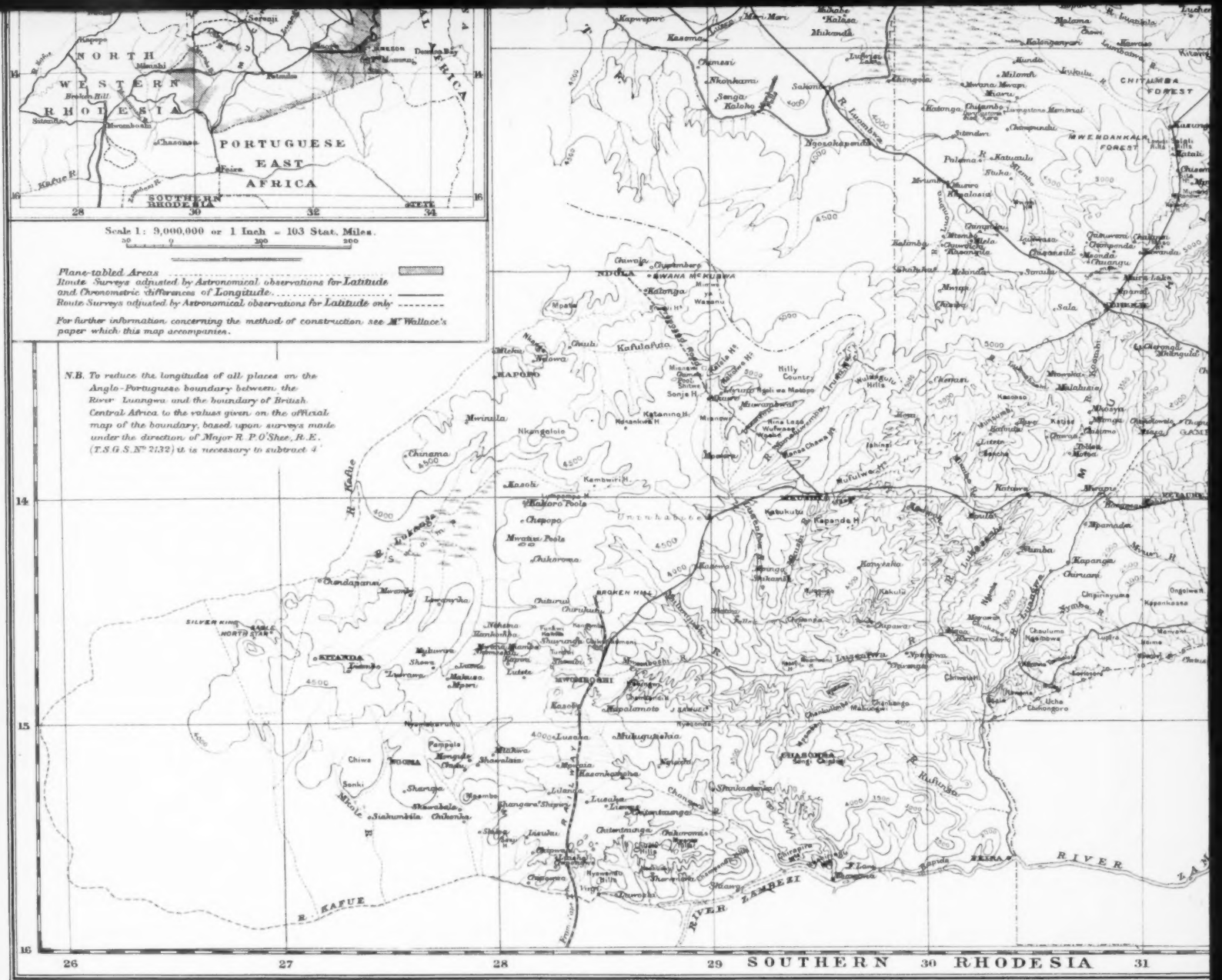
(1) My five assistants on trip; (2) Temple at Yung-p'ing Fu, alongside mission compound; (3) East wall at Yung-p'ing Fu; (4) Outside east gate at Yung-p'ing Fu; (5) North gate at Yung-p'ing Fu; (6) Village of Lêng-k'ou-kuan, showing Great Wall; (7 and 8) Great Wall at Lêng-k'ou-kuan; (9) Custom-house at Lêng-k'ou-kuan, with section of Great Wall; (11) Section of Great Wall outside Lêng-k'ou-kuan; (12) Our company passing through Ta-chang-tzŭ; (13) Manchu women and children at T'u-shih-mên; (14) Temple to god of war at Lo-t'o-ling; (15) Our animals in Chinese inn yard; (16) Our plane-table on top of Pa-huo-chih-ling; (17) Pack-mules ascending Pa-huo-chih-ling; (18) A rough road near the T'u-shan; (19) Chinese hut on top of pass near T'u-shan; (20) Village of Ch'ê-ch'ang-kou, taken from pass; (21) The Ch'ing-lung Ho, 70 miles north of Yung-p'ing Fu; (22) A rest by the way; (23) Yü-lin-shan on the Ch'ing-lung Ho; (24) Pastoral scene *en route* to T'a-tzŭ-kou; (25) Lama priest with stocking of Emperor K'ang-hsi; (26) Confucian temple in new schools at T'a-tzŭ-kou; (27) Temple to god of war at T'a-tzŭ-kou; (28) Kuei-hsing-lou at T'a-tzŭ-kou; (29) Temple to god of wealth at T'a-tzŭ-kou; (30) Mineral water springs at Je-shui-t'ang; (31) Mahommedan inn at Mang-niu-ying-tzu; (32) Pack-mules carrying skins near Ta-ming-ch'eng; (33 and 34) The Famous Pagoda at Ta-ming-ch'eng; (35) Shih-san-t'ai-pao, near Ta-ming-ch'eng; (36) Mongol women at Ta-ming-ch'eng; (37) Types of Mongol faces; (38) Mongols worshipping at the Famous Pagoda; (39) Inn yard at Mei-li Ho near Hata; (40) Village of Ma-chia-tzŭ, near Hata; (41) Official at Hata with foreign visitors; (42) Foreign visitors at Hata; (43) Chinese official at Hata with bodyguard; (44 and 52) Street scene at Hata; (45) Showing rooms prepared for Prince Su, Hata; (46) Street scene, Hata, with cartwright's stock-in-trade piled up; (47) Residence of Mongol Prince of Wêng-niu-t'e at Hata; (48) Second brother of Prince of Wêng-niu-t'e; (49) Third brother of Prince of Wêng-niu-t'e; (50) Son and heir of Prince of Wêng-niu-t'e; (51) Lama abbot of princely rank; (53 and 54) Fording the Shih-la-ka Ho, 5 miles from Hata; (55) Native coal-mine at Yuan-pao-shan; (56) Lao Ho near Shan-tsui-tzŭ; (57) Mongols watering animals at Old Palace on Lao Ho; (58 and 59) Ruined house of murderer of Ao-han prince, Old Palace; (60) Whisky distillery at Yü-t'ien-kao owned by lama prince; (61) Mongol hut at Yü-t'ien-kao, Lao Ho; (62) Mongol Tama Laoyeh at Hsiang-shui, Lao Ho; (63–66) Views of waterfall at Hsiang-shui; (67) Pastoral scene at Hsiang-shui; (68) In the sand deserts beyond Hsiang-shui; (69) Village of Cha-kan-tao-hai; (70) Lama temple in the grass-land, Lao Ho; (71) Tomb of lama abbot; (72–76) Mongol camels on the march; (77) Steward of Mongol prince, with imperial cart; (78) Arm of the Lao Ho, 5 miles from Shira-muren; (79) Lao Ho, 2 miles from Shira-muren, looking north-east; (80) Lao Ho, 2 miles from Shira-muren, looking south-west; (81 and 82) Dry bed of Shira-muren at confluence with Lao Ho; (83) Old Chinese "Neptune" at Shira-muren; (84) Servant viewing his spoiled garments after upset in Lao Ho; (85) Pastoral scene in grass-land; (86) Lunch in the sand-desert; (87) Moving a Mongol tent in the grass-land; (88) Manure heaped up for fuel in grass-land; (89) Mongol women 82 years old, with shaven head, and Mongol guide; (90) A lama guide on the grass-land; (91) House of wealthy Mongol in the sand-desert; (92) In the sand-desert, near Yang-shu-mu; (93) The Shih-pei Ho at village of that name; (94 and 95) Main street of K'u-lu-kou; (96) Tibetan lama prince at K'u-lu-kou; (97) Favourite riding-horse of Tibetan lama prince; (98) Private apartments of Tibetan lama prince; (99) Lama temple in monastery at K'u-lu-kou; (100) Marisami, the Indian surveyor, having his head shaved at K'u-lu-kou; (101) Mongols loading up their camels at K'u-lu-kou; (102) Mongol feeding camels in inn yard; (103) Wayside lama temple at Pei Tzu Fu; (104 and 105) Lama temple near Chao-yang Fu; (106) Old lama priest, 82 years old; (107) Village near Chao-yang Fu; (108 and 109) Distant view of pagoda in Ch'ao-yang Fu; (110) Street scene in Chao-yang Fu; (111) Pagoda in Chao-yang Fu; (112) Roof of lama temple, Chao-yang Fu; (113) Lama temple in Chao-yang Fu; (114) Ferry on Ta-ling Ho, at Chang-pao-ying-tzŭ; (115) Fording the Hsiao-ling Ho.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.


NORTH EASTERN
RHODESIA
Compiled by O. L. BERINGER from information obtained in the Survey Office, and from Surveys made by the Survey Department of North Eastern Rhodesia.
Scale 1: 2,500,000 or 1 Inch = 39·4 Stat. Miles.
EXPLANATION.
Administration Stations thus ..... FIFE
Missions ..... Kilubulu
Mines ..... SASARE
Roads .....
Telegraphs .....
Boundaries .....
The contour lines which must be considered approximate only are given at intervals of 500 feet.
L. TANGANYIKA
GERMAN EAST AFRICA
CONGO FREE STATE
L. NYERU
L. BANGWEULU
SWAMP
GAME RESERVE
BRITISH CENTRAL AFRICA
LAKE NYASA
NORTH WESTERN RHODESIA
R. Luvale
R. Luapula
R. Lovu
R. Chambesi
KALUNGWISI
SUMBU
KAWAMBWA
MBAWULA
OLD FORT ROSEBERY
Johnston Falls
BROKEN HILL
Kasama
Abercorn
Fife
Fort Rid.
Mpika
Serenje
Kapopa
Baobabs
Chiengi
Chisi I.
Chishi I.
Chungu
Mwenda
Kapoma
Kapwepwe
Mukanda
Kalasa
Ngomba
Songa
Mulungu
Chinsali
Isoka
Nakonde
Tanganyika
Ikunda
Mwibwi
Kawimbe
Kawaza
Kawesha
Kasenga
Kapopa
Kapoma
Kapwepwe
Mukanda
Kalasa
Ngomba
Songa
Mulungu
Chinsali
Isoka
Nakonde
Tanganyika
Ikunda
Mwibwi
Kawimbe
Kawaza
Kawesha
Kasenga

N.E. RHODESIA.
WALLACE.


33
34
8
9
10
11
LAKE RUKWA
GERMAN
EAST
AFRICA
ABERCORN
KALAMA
FORT HILL
BARONGA
MARIMBA
Deep Bay
Mt. Waller
Sanga
Nkata B.
BANDAWE
Ikunda
Kalombo
Chanya
Tambo
Mwaria
Lichaba
Tundua
Luchamba
Kangwa
Katimkasi
Kapopo
Kapasa
Kawe
Kalonda
Mwamba
Fonda
Ratongoshi
Mwamba
Kapeso
Chamba
Mwamba
Ilwa
Lwiashya
Folla
Masimba
L. Young
Mwamba
Mwaria
Lichaba
Mwamba
Mwamba
Mwam


NORTH WESTERN RHODESIA
PORTUGUESE EAST AFRICA
SOUTHERN RHODESIA
Scale 1: 9,000,000 or 1 Inch = 103 Stat. Miles.
Plane-tabled Areas
Route Surveys adjusted by Astronomical observations for Latitude and Chronometric differences of Longitude
Route Surveys adjusted by Astronomical observations for Latitude only
For further information concerning the method of construction, see Mr Wallace's paper which this map accompanies.
N.B. To reduce the longitudes of all places on the Anglo-Portuguese boundary between the River Luangwa and the boundary of British Central Africa to the values given on the official map of the boundary, based upon surveys made under the direction of Major R. P. O'Shee, R.E. (T.S.G.S. N° 2132) it is necessary to subtract 4'.
SOUTHERN RHODESIA
R. KAFUE
RIVER ZAMBEZI
R. LUANGWA
R. LUNSEMFWA
R. LUKUSASHI
R. KAFUE
CHITIMBA FOREST
MWENDANKALA FOREST
NIUKA
NYAMBA
KAPOPO
KAFULAFUTA
KATANINO H.
KASOLO
CHEPOPO
MWAMBA POOLS
CHIKUNGA
BROKEN HILL
KAPANDE H.
KATUKUTU
MWOMBOSHI
KASOMPE
MUKUGUSHA
CHIASONGA
MUSONKOSHA
LUSAKA
MUMBWA
KATUNGA
KATUMBA
KATOMA
KATOMBORA
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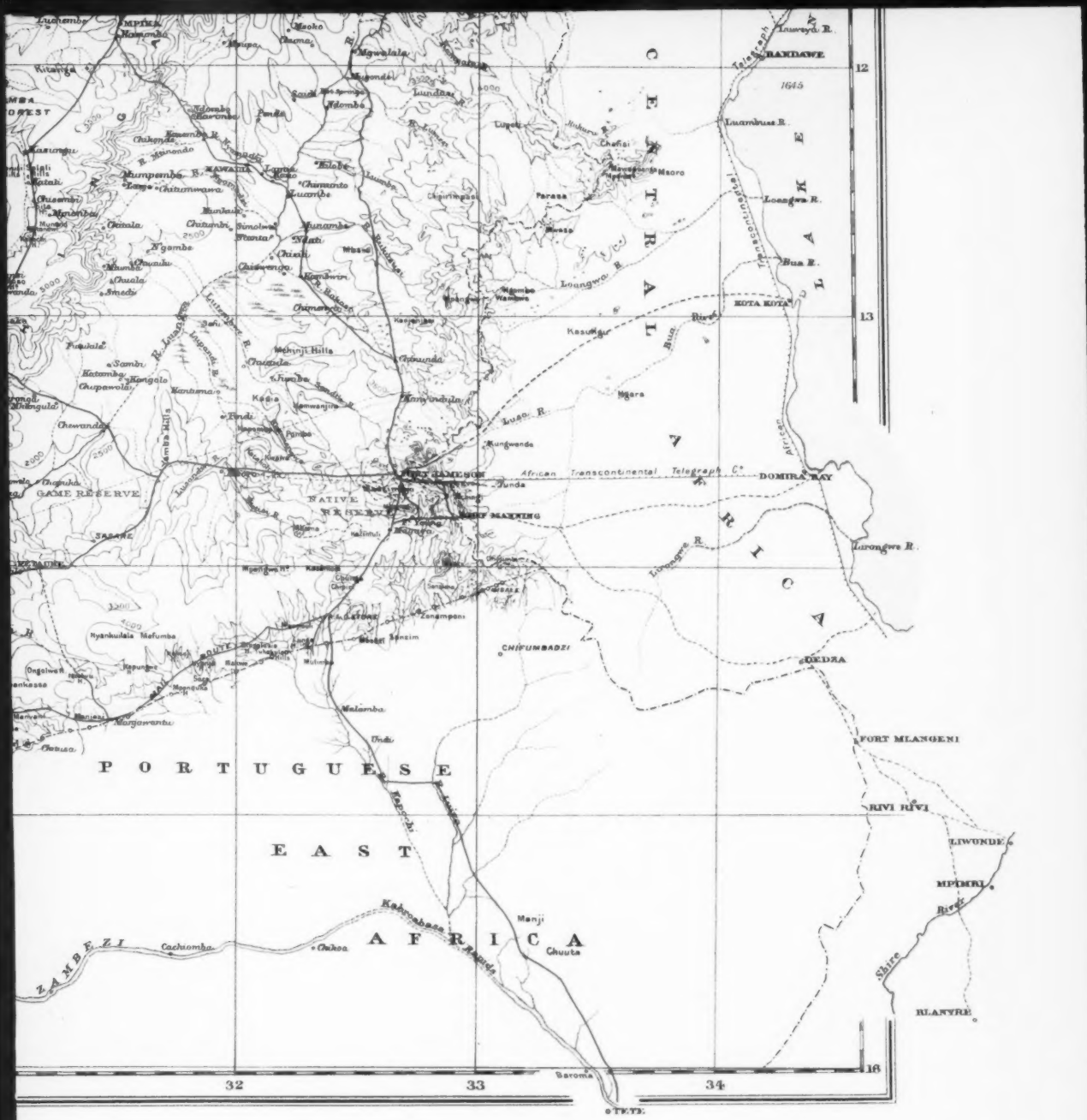
CENTRAL AFRICA
LAKE
NYASA
PORTUGUESE
EAST
AFRICA
NATIVE RESERVE
GAME RESERVE
FORT JAMESON
FORT MANNING
FORT HILL
KOTA KOTA
DOMIRA BAY
FORT MLANGENI
RIVI RIVI
LIWONDE
MPIMBI
BLANYRE
CHIPUNDADZI
DEDZA
NEKOLOMA
MAWAILA
African Transcontinental Telegraph Co.
Zambesi
Shire
Kafirabasa Rapids
Cachomba
Chuuta
Manji
Baroma
TETE
12
13
16
32
33
34